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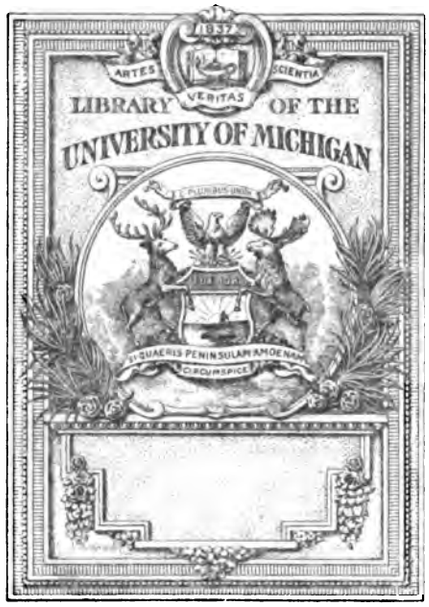
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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

UNDERGROUND WATER RESOURCES OF LONG ISLAND, NEW YORK

BY

A. C. VEATCH, C. S. SLICHTER, ISAIAH BOWMAN,
W. O. CROSBY, AND R. E. HORTON

WASHINGTON
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1906

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
Washington, D. C., July 7, 1904.

SIR: I transmit herewith the manuscript of a paper entitled "The Underground Water Resources of Long Island, New York," by Messrs. A. C. Veatch, Charles S. Slichter, Isaiah Bowman, W. O. Crosby, and R. E. Horton. The field work upon which the report is based formed a part of a detailed investigation of the geology and water resources of the island conducted by Mr. M. L. Fuller, chief of the eastern section of the division of hydrology, assisted by Mr. Veatch, to whom was given the immediate supervision of problems relating to underground waters.

The paper deals with an area in which the problems relating to underground waters are of great importance, especially as they affect city and town supplies. Great interest is manifested in such waters throughout the area, and it is thought that the report, which is the result of unusually detailed work, will prove of great value to engineers and others who may be interested in public or private supplies from underground sources.

A separate report, treating the geology of the island in more detail, has been prepared by Mr. Fuller and will soon be transmitted for publication.

Very respectfully,

F. H. NEWELL,
Chief Engineer.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

UNDERGROUND WATER RESOURCES OF LONG ISLAND, NEW YORK.

By A. C. VEATCH, CHARLES S. SLICHTER, ISAIAH BOWMAN, W. O. CROSBY, and R. E. HORTON.

CHAPTER I.

OUTLINES OF THE GEOLOGY OF LONG ISLAND.

By A. C. VEATCH.[a]

INTRODUCTION.

As Long Island is the largest island on the eastern coast of the United States, and is of such size, 120 miles long and 23 miles wide, that it is a more or less noticeable feature on even very small-scale maps, little need be said of its general geographic position.

TOPOGRAPHY.

In shape Long Island resembles a huge fish, with the head toward New York. This rude resemblance caused the early whalers to apply the names North Fluke and South Fluke to the two projections which form the tail.

A range of hills having a relief of from 100 to 200 feet gives topographic expression to each of the flukes; and continuing westward, these ranges coalesce north of the center of the island near the Suffolk-Nassau county line, where they reach their maximum elevation of 420 feet at High Hill. Westward a group of rolling hills, occasionally reaching a height of over 300 feet, and not separable into distinct lines, continues to the Narrows at Brooklyn. South of these hill ranges the land is comparatively level and slopes off gently to the sea or forms more or less elevated table-lands between the two lines of hills. The northern shore, skirted by the hills, is rugged and precipitous, with long, narrow bays, while the southern shore passes gradually from a gently sloping plain into a salt marsh inclosing broad, shallow bays, beyond which is a barrier beach.

[a] A more detailed report on the geology of Long Island is now in preparation, and the discussion of local data, as well as questions of correlation, has therefore been omitted in this outline, which has been condensed from the writer's complete report on the geology.

The hills are very irregular and even the plains between the two ranges of hills are by no means level, but are pitted by somewhat circular depressions found in glaciated regions and commonly called "kettle holes." On Long Island many of those contain water, forming charming little lakes and ponds, which add much to the picturesqueness of the region.

In general the topography has a glacial aspect, and the glacial forms are so prominent that the fact that the major topographic features are of pre-Glacial origin is commonly overlooked.

LITERATURE.

The literature dealing with the geology and water resources of Long Island is very extensive, and will be presented in detail in a paper on the Geology of Long Island, now in preparation. Only a few of the more important titles are presented in the accompanying list:

MATHER, W. W. Geology of the first geological district. Geol. New York, pt. 1, 1843.

LEWIS, E. Ups and downs of Long Island. Pop. Sci. Monthly, vol. 10, 1877, pp. 434–446.

UPHAM, WARREN. Terminal moraines of the North American ice sheet. Am. Jour. Sci., 3d ser., vol. 18, 1879, pp. 81–92, 197–209.

DANA, J. D. Long Island Sound in the Quaternary age, with observations on the submarine Hudson River channel. Am. Jour. Sci., 3d ser., vol. 40, 1890, pp. 425–437.

MERRILL, F. J. H. Geology of Long Island. Annals New York Acad. Sci., vol. 3, 1886, pp. 341–364.

HOLLICK, ARTHUR. Preliminary contributions to our knowledge of the Cretaceous formation of Long Island and eastward. Trans. New York Acad. Sci., vol. 12, 1893, pp. 222–237.

——— Some further notes on the geology of the north shore of Long Island. Trans. New York Acad. Sci., vol. 13, 1894, pp. 122–130.

——— Dislocations in certain portions of the Atlantic coastal plain strata and their probable causes. Trans. New York Acad. Sci., vol. 14, 1894, pp. 8–20.

DE VARONA, I. M. History and description of the water supply of the city of Brooklyn. 1896, 306 pp., 8 tables, 45 pls.

(Gives bibliography of the Brooklyn waterworks on pp. 301–306.)

FREEMAN, JOHN R. Report upon New York's water supply. New York, 1900, 587 pp., 113 figs.

THE MERCHANTS' ASSOCIATION. The water supply of the city of New York. 1900, 62 pp., 25 pls.

RIES, HEINRICH. Clays of New York. Bull. New York State Mus., No. 35, 1900, pp. 495, 572, 573, 595–607, 692, 817–822.

WOODWORTH, JAY BACKUS. Pleistocene geology of portions of Nassau County and Borough of Queens. Bull. New York State Mus., No. 48, 1901.

SALISBURY, R. D. Description of New York City. Geologic Atlas U. S., folio 83, U. S. Geol. Survey, 1902.

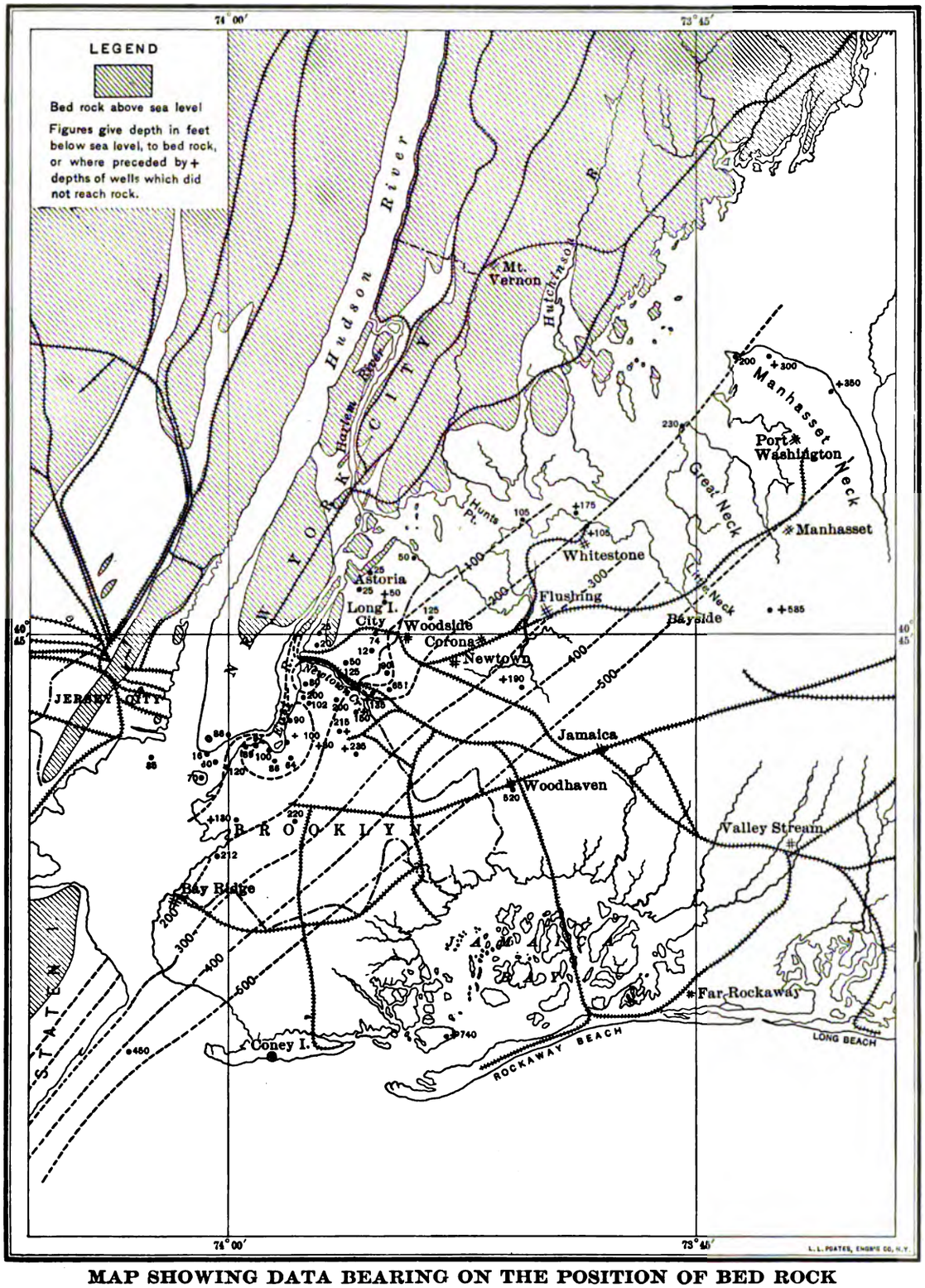
SPEAR, WALTER E. Long Island sources. Rept. Commission on Additional Water Supply for the City of New York, Nov. 30, 1903, New York, 1904, appendix 7, pp. 617–806.

THE BASEMENT ROCKS.

Although bed rock underlies all Long Island at a greater or less depth, it outcrops only along East River, at Long Island City and Astoria, where Merrill has recognized two divisions—the Fordham gray gneiss and the Stockbridge dolomite, the former of probable pre-Cambrian and the latter of Silurian or Cambro-Silurian age.[a] In the Fordham gray gneiss are occasional dikes and bosses of granite and intrusions of diorite.

These rocks are the remnants of strata which were profoundly altered by pressure and heat, by folding and faulting, and then reduced by erosion (fig. 1), dur-

[a] Merrill, F. J. H., Description New York City, Geologic Atlas U. S., folio 83, U. S. Geol. Survey, 1902, pp. 3–5.



MAP SHOWING DATA BEARING ON THE POSITION OF BED ROCK IN WESTERN LONG ISLAND, NEW YORK, AND VICINITY.

By A. C. Veatch.

1904.

Scale

5 0 5 10 miles

ing the ages that elapsed between the Silurian and the Cretaceous periods. The many changes of this old land surface and its topographic aspect at different stages before the Cretaceous can only be partly outlined, but the history since the beginning of the Cretaceous can be inferred more or less completely.

The surface of these older beds, so far as it has been revealed on Long Island by borings that penetrate the mantle which has protected it from erosion since the early Cretaceous, has a few minor irregularities, but, on the whole, slopes gently to the south and east at a rate of about 100 feet per mile. The unevenness of the present surface is very slight when compared with the great irregularity (fig. 1) indicated by the structure. On Pl. I is shown the depth to bed rock in the western portion of the island; in the eastern part of the island the depths at which bed rock was encountered, at 655 feet at Greenport (892[a]) and at 150 feet at Fishers Island (919[a]), show a similar slope.

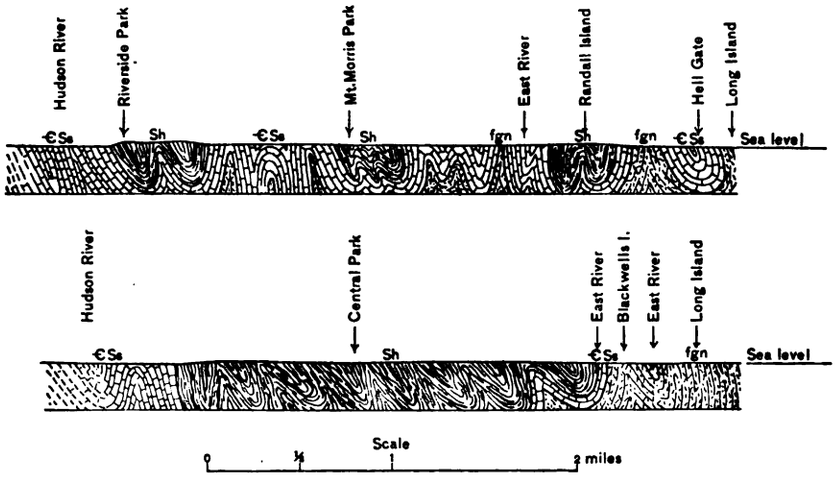


FIG. 1.—Sections from Hudson River to Long Island, showing in a general way the folded and eroded character of bed rock underlying Long Island (Merrill 1902); fgn, Fordham gneiss (pre-Cambrian); €Ss, Stockbridge dolomite (Cambro-Silurian); Sh, Hudson schist (Silurian).

This sloping surface, with its minor irregularities, was probably at one time nearly horizontal and formed a part of the great, almost level, plain known as the Schooley peneplain,[b] which extended over a large part of the eastern United States and which resulted from long-continued erosion under very uniform conditions. It owes its present slope or dip to the very broad folding which began near the beginning of the Cretaceous and which, after several minor halts and fluctuations, elevated the Schooley Mountain in New Jersey 1,500 feet and depressed the old surface in the Long Island region.

[a] The numbers given in parentheses throughout this paper correspond with those used on Pl. XXIV and in Chapter IV, where detailed records are given.

[b] Davis, W. M., and Wood, J. W., Geographic development of northern New Jersey: Proc. Boston Soc. Nat. Hist., vol. 24, 1890, pp. 365–423. Willis, Bailey, The northern Appalachians: Mon. Nat. Geog. Soc., vol. 1, No. 6, pp. 169–202, 1895; Salisbury, R. D. Phys. Geog. New Jersey: Final report State geologist New Jersey, vol. 4, 1898, pp. 83–85.

CRETACEOUS.

CONDITIONS OF DEPOSITION.

By this change of level at the beginning of the Cretaceous period the sea again covered this area, and the rejuvenated streams carried into it the deeply weathered material from the surface of the old Schooley peneplain. The strata for 300 or 400 feet above the bed rock are therefore composed almost entirely of the products of long-continued weathering and present a peculiar mingling of sand and plastic clays, often brightly colored, which are more or less distinct from the beds that follow.

CHARACTER OF DEPOSITS.

These irregular-bedded varicolored clays with light-colored quartz sands and gravels, which characterize the base of the Cretaceous system in this region, show an increasing percentage of sand in their upper portions, and pass more or less gradually, on the north shore, into the light-colored quartz sands with occasional irregular clay beds which form the upper strata of the pre-Pleistocene series, and, on the south shore, into the fine gray lignite-bearing sands and clays of the same age. The thick greensand marls of the New Jersey section are almost wholly absent, their presence being merely suggested in the West Hills, at Quogue and Bridgehampton. The absence of greensand marls, the extreme scarcity of marine fossils, and the presence of plant remains, indicate shoal water, or near-shore conditions during the several epochs in which these rocks were deposited.

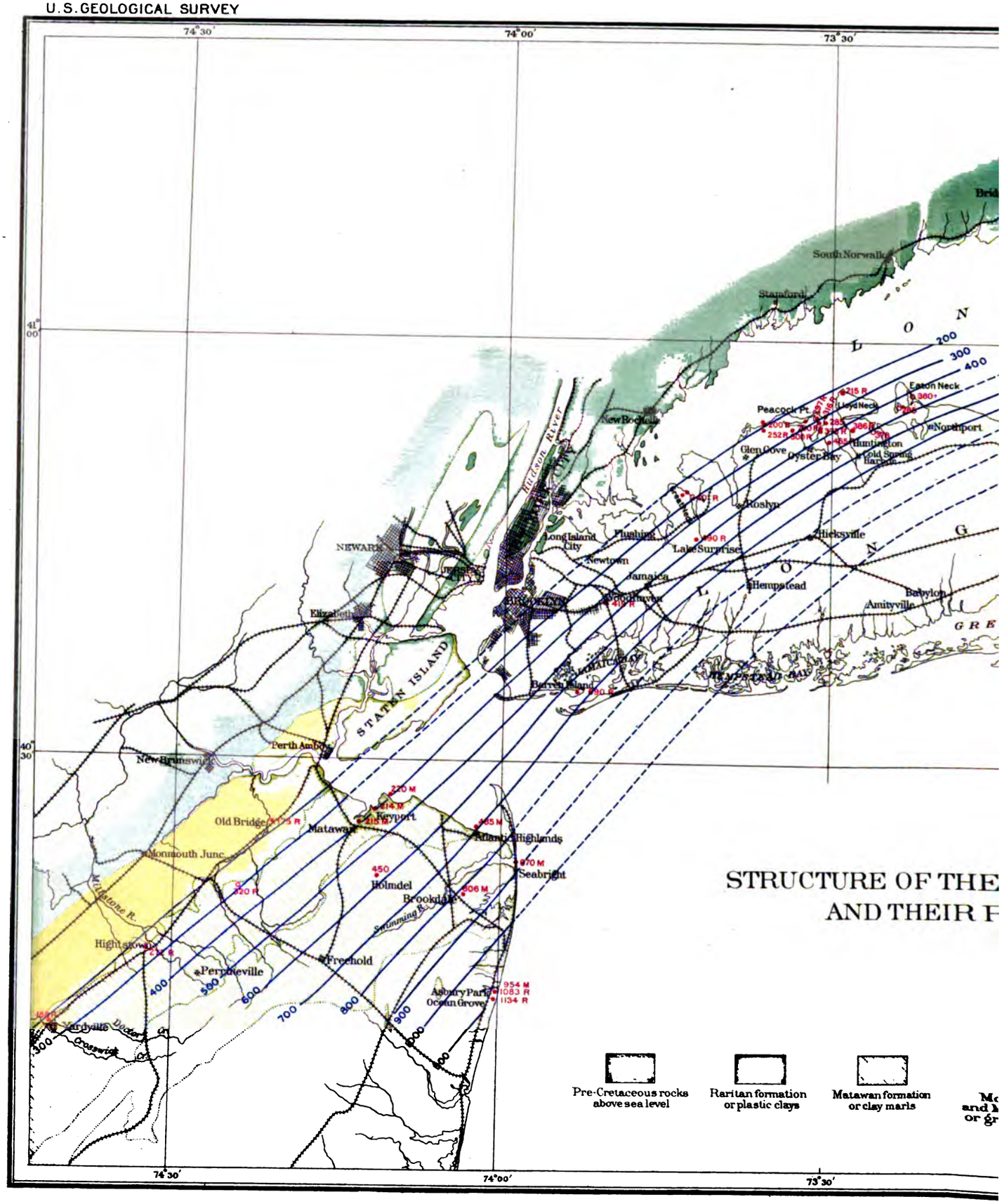
As a result of the long-continued weathering to which all the material composing these beds has been subjected, the sand beds lack the readily broken-down minerals so common in glacial deposits, and the gravel beds do not contain compound crystalline or transported clastic pebbles. The gravels from the lowest to the highest (with but one doubtful exception) are composed of quartz or locally derived quartz-conglomerate, with occasional very much decomposed milk-white chert fragments. This difference in composition is the most serviceable criterion for separating the pre-Pleistocene from the Pleistocene beds in this region.

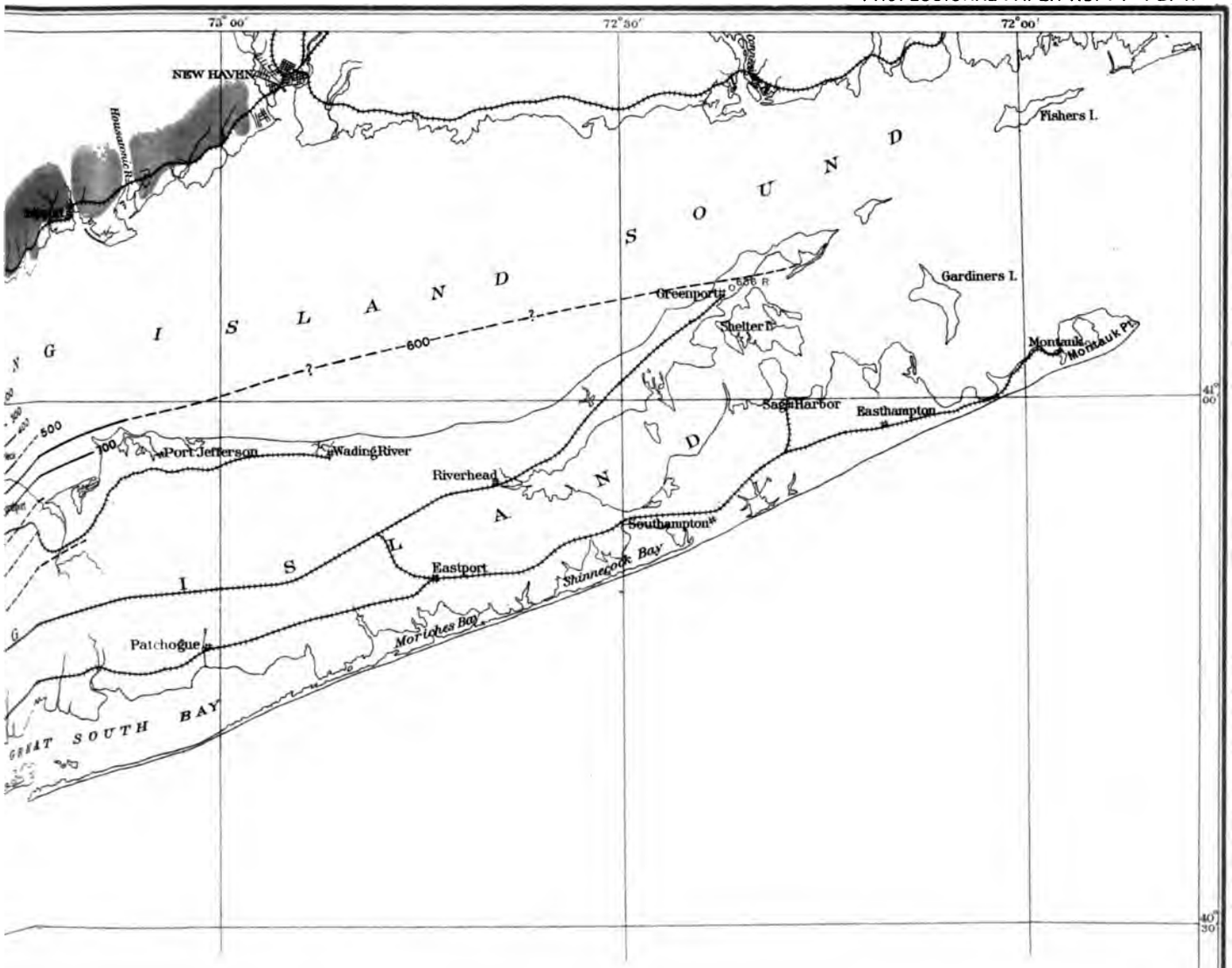
STRUCTURAL RELATIONS.

These Cretaceous beds are now not only almost entirely hidden by Pleistocene deposits, but are so disturbed in the few limited outcrops on the north shore (Pl. III) that neither the original slope of the strata, the amount of deformation, either horizontal or vertical, nor the relation of one outcrop to another can be satisfactorily determined. The apparently undisturbed outcrop in the West Hills furnishes no extended exposure, and even here the structure is concealed by hill creep and landslides.

Any knowledge of the structure is, therefore, dependent upon well records, and these have fortunately revealed a key bed that is not only satisfactorily persistent on the island, but continues in New Jersey, and furnishes a new basis for a comparison of the stratigraphy. A critical study showed that the top of a water-bearing sand situated 150 to 200 feet above bed rock in 14 north shore wells (see

U.S. GEOLOGICAL SURVEY





MAP SHOWING
THE BASAL CRETACEOUS BEDS ON LONG ISLAND, NEW YORK
AND THEIR RELATION TO THE CRETACEOUS OF NEW JERSEY

By A. C. Veatch

1904

Scale

5 0 5 10 15 20 25 30 miles

LEGEND

- Monmouth, Rancocas and Manasquan formations or green sand marl series
- • Successful wells
- R Lloyd sand horizon
- o Unsuccessful wells
- M Basal Matawan horizon
- 300 Figures in red indicate depth in feet below sea level
- 200 Blue contours indicate approximate top of the Lloyd sand; figures give depths below sea level

73° 00'
72° 30'
72° 00'

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p. 65) has a very regular southeastward dip (Pl. II) and a continuation of the lines of equal depth parallel to the line of strike showed that not only the nonwater-bearing gravels of the Woodhaven well (143) and the good water carriers of the Barren Island wells (129–132) belonged to the same horizon, but also the water-bearing beds in certain wells in New Jersey, which encounter a gravel horizon at a somewhat similar height above bed rock. The position of the top of this gravel and sand, which it will be convenient to call the Lloyd sand from its fossiliferous development in the well (633) on Lloyd Neck, is shown in Pl. II.

As indicated on Pl. II, in northern Long Island on a 6-mile line, the dip is as much as 80 feet per mile, while in New Jersey on a 22-mile line it is only half so much. It is quite probable, therefore, that the dip on Long Island becomes somewhat less to the south, and that on the south shore, about Amityville and Babylon, wells will strike this sand at even a less depth than indicated on Pls. II and XVI.

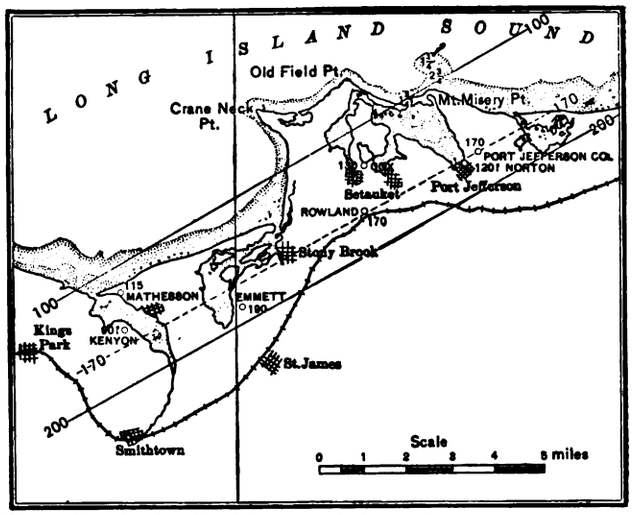


FIG. 2.—Map showing dip of Cretaceous beds near Setauket, N. Y. Figures at wells give depth of water-bearing stratum below sea level.

Some additional evidence bearing on the general structure of this region is furnished by the dip indicated by a few wells near Setauket (fig. 2), which reach a coarse sand and gravel about 600 or 700 feet above the Lloyd sand. The original calculation of the dip, based on the similarity suggested by the Cox (763), Rowland (760), and Emmett (752) records, has been confirmed by the record and samples from the Port Jefferson Company well (811). A comparison of the strike of this bed (fig. 2) with that of the Lloyd sand (Pl. II) shows it to be very nearly parallel, although the dip is much nearer that usually found in New Jersey—about 40 feet per mile.

PRESENT DISTRIBUTION.

A detailed knowledge of the distribution of the Cretaceous on Long Island is, like the determination of the structure, almost wholly dependent on well records. The available data are shown on Pl. III. This map emphasizes two points: Although (1) the Cretaceous beds have determined the major topographic relief of the island (see also Pl. V, *A*–*A*), (2) near the western end they have been deeply trenched by a broad north-south valley, representing the outlet of the Sound River (Pl. VI).

The most important outcrop of Cretaceous rocks is in the West Hills, on the road leading from Melville to Hicksville (Pl. III). The following section was observed

at this point early in the spring of 1903, just after the landslips of the previous winter had been removed by road graders and the section further cleaned up with a spade:

Section just west of Melville, N. Y.

[Top of section about 300 feet above tide.]

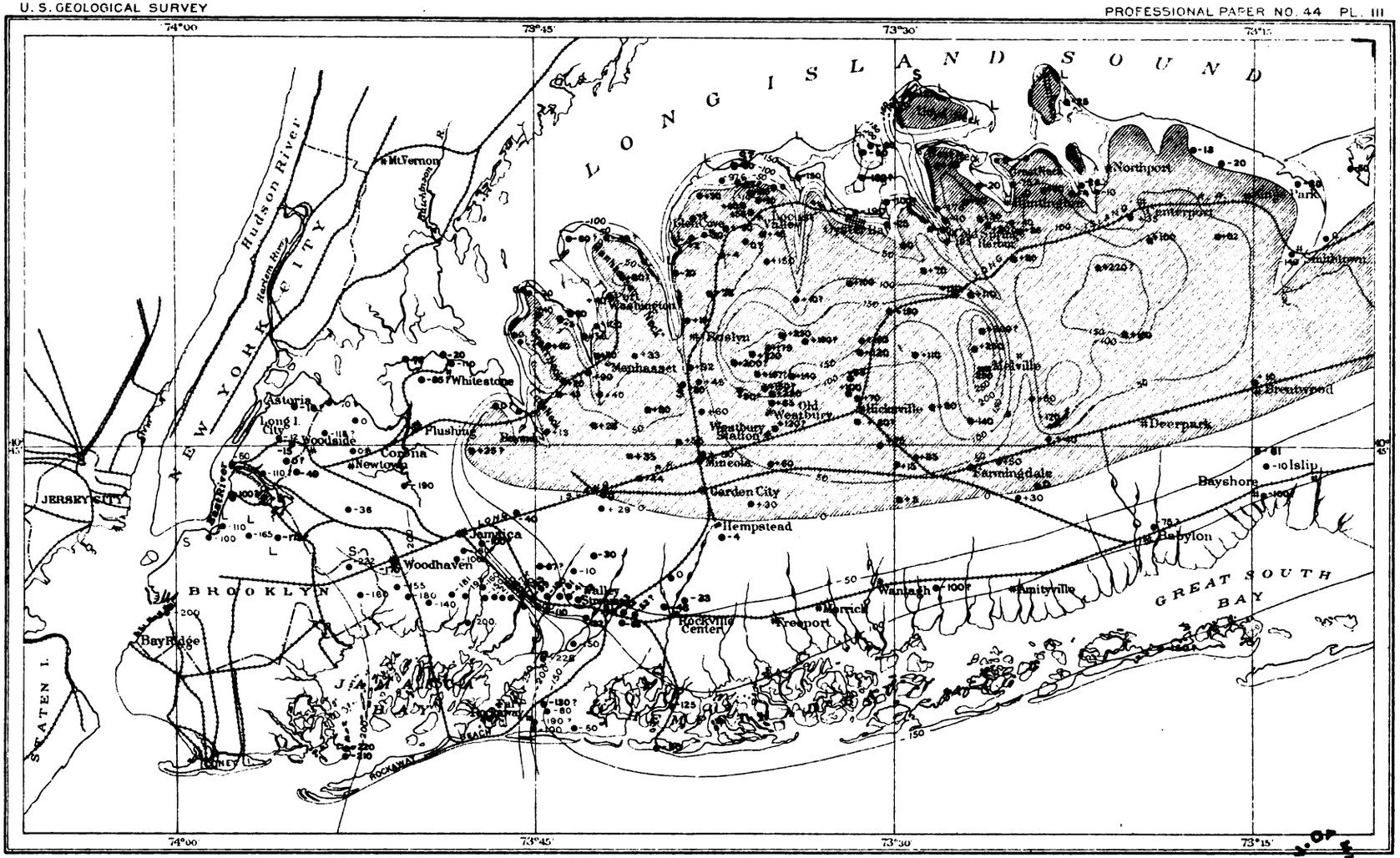
	Feet.
Pleistocene:	
1. Horizontally bedded yellow sand and quartz gravel, with a few very much weathered compound pebbles. Near the upper part of the section the gravel is a very bright orange. (Pl. IV, *A*)	35
Miocene (?): Fluffy (Beacon Hill) sand:	
2. Orange clayey sands, fine, micaceous, containing iron scales and small gravel; closely resembles sand at Kirkwood, N. J.	3
Cretaceous:	
3. Dark-colored, lavender, green, and black sandy clay, weathering yellow	3
4. Horizontally bedded, finely laminated red clayey sand, with a few rounded quartz pebbles (weathering product of bed below)	2.5
5. Horizontally bedded, finely laminated green, white, and pink clayey sand, containing some greensand grains and rounded quartz pebbles	3
6. Ferruginous sandstones	0.3
7. Yellow sand with ferruginous plates	0.5
8. Irregularly bedded gray clayey sand, blotched with red and yellow, becoming more sandy above, and passing into a pink or red sand with lens-shaped masses of white clay	9.5
9. Covered	0.5
10. White clayey sand with large quartz gravel	2
11. Covered	1
12. Stratified orange-colored sandy clay, with ferruginous plates	1
13. Very black sand and gravel, stained, probably with manganese dioxide	0.2
14. Coarse white sand and yellow clayey sand, horizontally, though rather irregularly, bedded, the bedding lines being darker and rather more clayey than the rest. (Pl. IV, *B*)	19

STRATIGRAPHIC SUCCESSION.

A study of the local data indicates that from a stratigraphic standpoint the greensand beds in the Quogue (858–859) and Bridgehampton (897) wells, and the impure greensand marls in the Melville section (p. 20) are to be regarded as the highest beds of the pre-Pleistocene series which have thus far been recognized. Wells which might show younger beds may be looked for east of Babylon, but the wells in this region, except those at Quogue and Bridgehampton, are so shallow and the data so meager that the lignitiferous sands of the Pleistocene can not with certainty be separated from the older, and while a portion of these sands are doubtless pre-Pleistocene, their thickness can not be very great and a generalized section of the pre-Pleistocene beds may be commenced with the greensand layer above mentioned.

Generalized section of pre-Pleistocene deposits on Long Island.

	Feet.
1. Impure greensand marl developed in about the same stratigraphic position in the Melville section and in the wells at Quogue and Bridgehampton	50±
2. Sands with irregular clay beds. The beds, though showing considerable lignitic material, are commonly lighter on the north shore and in the hill lands than on the south shore. They are shown in detail in the many shallow wells in northern Oyster Bay Township, in the Lake Success well (317), the Hollis well (220), the Wheatley Hill wells (particularly 431), in the Melville section, in the Barren Island wells, and in many of the test wells of the Brooklyn waterworks east of Jameco, as well as in the Long Beach, Barnum Island, Quogue, and Riverhead wells	1,000±



MAP SHOWING THE DISTRIBUTION OF CRETACEOUS ON WESTERN LONG ISLAND, NEW YORK

By A. C. Veatch
1904
Scale

0 5 10 miles

LEGEND

- Outcrops of the Cretaceous
- Area of Cretaceous above sea level
- Approximate contours of Cretaceous surface
- +30 / −156 — Points at which the Cretaceous was encountered, with elevation in feet above or below sea level
- +60 / −220 — Points at which the Cretaceous was not encountered, with elevation in feet above or below sea level
- S — Cretaceous fossils, shells, in place
- s — Cretaceous fossils, shells, not in place
- L — Cretaceous fossils, leaves, in place
- l — Cretaceous fossils, leaves, not in place

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	Feet.
3. Varicolored clay, often bright red, in wells on the north shore; may be entirely absent or very thin, as in the Cox well (564) in Hempstead Harbor, and the Bevin well (670) on Eaton Neck; with the clay layers in the succeeding beds it sometimes reaches a thickness of between 400 and 500 feet, as in the Ward well (628) near Huntington, but this thickness, as shown by near-by wells (620), is abnormal, the average thickness being about 100 to 150 feet.	0–150
4. Lloyd sand. Yellow to white quartz sand and gravel, with occasional clay layers, as at Woodhaven; separated from bed rock by clay beds, but at Greenport apparently resting directly upon it; contains much decayed white chert, and in one case (633) marine fossils. Maximum thickness shown at Peacock Point and Lake Success (317). Lithologically this gravel is identical with the older portions of the yellow gravel of New Jersey, and suggests that a part of this complex may represent undisturbed Cretaceous outcrops	80–90
5. Probable thickness of beds between the Lloyd gravel and bed rock	100–200

RELATION TO ADJACENT AREAS.

Fortunately for the purposes of this study the pre-Pleistocene beds in New Jersey, particularly those belonging to the Cretaceous, are not only well developed but well known, and furnish a ready near-by standard with which to compare the Long Island section. Before undertaking this comparison in detail, it will be necessary to review briefly the geologic succession in that region, and to give the thickness and general character of the main lithologic units. In various reports of the New Jersey geological survey these details are given at length, and it is from this source that the following abstract has been prepared:

TABLE I.—*Cretaceous and Tertiary formations of New Jersey.*

Salisbury.[a]	Clark.[b]		Cook.[c]	
Bridgeton	Lafayette (Yellow Gravel in part)		Yellow gravel.	
Beacon Hill Miocene	Chesapeake		Miocene (glass sands and sandy clays, astringent clays).	
Marl series	Shark River (Eocene)		Upper marl.	Marine series.
	Manasquan			
	Rancocas	Vincentown lime-sands	Middle marl.	
		Sewell marls		
	Monmouth	Redbank sands	Red sand.	
		Navesink marls	Lower marl.	
		Mount Laurel sands		
Clay marl formation	Matawan	Hazlet sands	Clay marl.	
		Crosswick clays		
Raritan	Raritan		Plastic clays—Nonmarine series.	

[a] Final Rept. State Geol. Survey N. J., vol. 4, Physical Geography, 1898, p. 117. Ann. Rept. N. J. Geol. Survey, pp. 13–15, 1898.
[b] Ann. Rept. N. J. Geol. Survey p. 334, 1894; Bull. Geol. Soc. Am., vol. 8, pp. 315–358, 1897; Ann. Rept. N. J. Geol. Survey, p. 174, 1898.
[c] Geology of New Jersey, 1868, and subsequent publications. The "yellow sand" has been omitted, as Clark has shown that it has not the stratigraphic position indicated by Cook.

The Miocene strata which unconformably overlie the Cretaceous and Eocene beds are as a rule coarse and lighter colored at the outcrop than in the embed. At the outcrop these beds are commonly yellow or brown, while in the embed they are darker and the percentage of clay material is greater. They cap many of the

high hills of the coastal plain as outliers in the Cretaceous area, and underlie all of the plain south of the Cretaceous outcrop.

The Cretaceous, including the lithologically similar Eocene Shark River beds, may be divided on lithologic grounds into (1) the marl series or greensand beds, (2) the clay marls (or Matawan), and (3) the plastic clays (or Raritan). The general character and relation of these beds are well shown graphically in fig. 3 and Pl. II, and may be briefly stated as follows:

	Feet.
1. Marl series. Greensand marl, sometimes with some clayey material which produces gray or chocolate-colored marls, generally quite fossiliferous, and at times calcareous. Toward the base the amount of sandy material increases and the beds take on a ferruginous aspect with a decreasing percentage of glauconite	262–[a]430
2. Clay marls or Matawan. Highly ferruginous brown sands, at times coarse and white, passing into slate and drab-colored clays interstratified with white sand, and finally into dark-colored or black clays. Marine fossils are by no means as abundant as in the overlying layers, and are as a rule poorly preserved	275–524
3. Plastic clays or Raritan. Clays and sands, often brightly colored; beds generally become more sandy in the upper portion, though they sometimes contain dark-colored clay, and are then not separable from the overlying Matawan or clay marl. The differentiation of this horizon has rested on the plastic clays which it contains, and its general nonmarine character	347

A comparison of this section with the general section found on Long Island shows little similarity. In part this difference is due to the relatively small amoun-

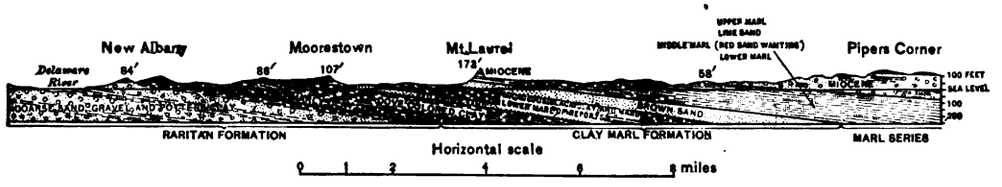

FIG. 3.—Section from Delaware River to Pipers Corner, N. J., showing character and relation of Cretaceous horizons. (Salisbury, 1896.[b]) Black represents surficial deposits. Length, 20 miles; height, 473 feet.

of information available regarding the older beds on Long Island, and will probably disappear as the data increase. In part, however, it is real; for although the Pleistocene deposits effectually mantle almost the entire island and prevent a careful study of the older beds, the well data are now complete enough to positively indicate the absence of any great fossiliferous greensand marl bed 250 to 450 feet thick, such as occurs in New Jersey. Only in the lower beds is there any similarity, and these have thus far furnished the only bases for the correlation of the two sections. The manifest lithologic resemblance of the few outcrops on the north shore to the Raritan beds of New Jersey caused Mather at a very early date to correlate them. Later the work of Newberry, Hollick, and White on the fossil plants of Long Island and the New England islands confirmed this tentative correlation. To these data it is now possible to add direct stratigraphic evidence, which confirms the conclusion reached by Ward from a study of the flora: That the beds furnishing the fossil leaves on Long Island (the Island series) are somewhat younger, and therefore stratigraphically higher than the Amboy clays.[c]

[a] For thickness shown in the Asbury Park well, see Rept. N. J. Geol. Survey, 1896, p. 73.

[b] Ann. Rept. New Jersey Geol. Survey for 1895, 1896, Pl. II.

[c] Ward, Lester F., The Potomac formation: Fifteenth Ann. Rept. U. S. Geol. Survey, 1895, p. 335; Age of the Island series: Science, new ser., vol. 4, 1896, pp. 757–760.

A. MANNETTO GRAVEL NEAR TOP OF MELVILLE SECTION.

B. CRETACEOUS SAND NEAR BASE OF MELVILLE SECTION.

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In this work the top of the Lloyd sand has proved a convenient plane of reference, and a study of the New Jersey records shows that it continues into New Jersey and can therefore be made a basis of correlation between the two sections. This extension is graphically shown in Pl. II. The considerations on which the prolongation of these lines from Long Island were based are: (1) The general line of strike of the Cretaceous beds; (2) a water horizon in the wells at Runyon[a] (white sand beneath 100 feet of white, red, and blue clay), Yardville,[b] Hightstown,[c] Jamesburg,[d] Asbury Park,[e] and Ocean Grove,[e] which is 150 to 200 feet below the base of the Matawan.

Woolman[f] has suggested that the Woodhaven and Barren Island horizons are a continuation of the horizons developed at Keyport,[g] Matawan,[h] Atlantic Highlands,[i] Brookdale[j] (644 feet), Holmdel,[k] Seabright,[l] and Asbury Park[m] (1,083 feet), but an attempt to include the horizon developed in these New Jersey wells causes the lines of equal depth to diverge from the general line of strike, and does not account for the depth reached in the Asbury Park and Ocean Grove wells. Woolman explains this greater depth by an assumed thickening of the Matawan, but Clark in reviewing the evidence is inclined to give to the Matawan in these wells a thickness of only about 400 feet.[n]

According to this hypothesis the lowest water-bearing layer would have about the position of the beds which were struck by the Runyon, Jamesburg, Hightstown, and Yardville wells, and which are 200 feet below the beds of the Matawan. Moreover, a water-bearing sand occurs in the Asbury Park well at a depth of 954 feet which seems the true continuation of this upper horizon. If the 200-foot line on Pl. II is called 0 and the other lines renumbered accordingly, the position of this upper horizon will be approximately indicated in all of the wells. Thus, near the 200-foot line will be found the Matawan and Keyport wells (215–220); near the 400-foot line, the Holmdel well (450);[n] near the 500-foot line the 465-foot horizon in the Atlantic Highlands well; near the 600, the 606 horizon of the Brookdale well; near the 700, the 670 of the Seabright well, and near the 900, the 954 Asbury Park horizon. The Lloyd sand is therefore equivalent to the lower horizon in the Asbury Park and Ocean Grove wells and is about 200 feet below the horizon in the other wells to which Woolman referred it. This upper horizon is regarded as either basal Matawan or uppermost Raritan, and the Lloyd sand is therefore a horizon in the Raritan about 200 feet below the base of the Matawan. In a general way, then, the 200 or 300-foot line marks the line of parting between the so-called marine and nonmarine

[a] Ann. Rept. New Jersey Geol. Survey for 1897-98, p. 246.
[b] Ibid., p. 281.
[c] Ann. Rept. New Jersey Geol. Survey, 1895, pp. 200, 201; Bull. U. S. Geol. Survey No. 138, 1896, pp. 66–67.
[d] Ann. Rept. New Jersey Geol. Survey, 1880, pp. 166–168; Bull. U. S. Geol. Survey No. 138, 1896, pp. 67, 68.
[e] Ann. Rept. New Jersey Geol. Survey 1896, pp. 72–75.
[f] Woolman, Lewis, Ann. Rept. New Jersey Geol. Survey, 1900, p. 77.
[g] Ann. Rept. New Jersey Geol. Survey, 1898, pp. 245–246.
[h] Ibid., p. 246.
[i] Ibid., p. 244
[j] Ibid., p. 228.
[k] Ibid., 1897, pp. 147–148.
[l] Ibid., 1900, pp. 76–77.
[m] Ibid., 1898, pp. 176–177.
[n] The difference in this case is clearly due to the generalized character of the record; quicksand is reported for some distance above the water-bearing layer, and doubtless in part represents the upward extension of the sand bed.

Cretaceous, and Cretaceous fossils would be expected south of this line on Long Island.

From these data the outcrops at Glen Cove and Sea Cliff are to be regarded as uppermost Raritan which has been, perhaps, slightly disturbed by folding, while the gray sands and clays at Greenwood are clearly Matawan, and the *Terebratula* found in the Roslyn well[a] naturally falls near the base of the Matawan. In the same way the Lloyd Beach clays are to be regarded as Matawan, unless they have been more profoundly disturbed by ice pressure than now appears; and the Little Neck and Fresh Pond areas fall far south in the Matawan. On account of the leaf remains found at Little Neck this locality has been referred to the Raritan, but the recent collections of Berry[b] in the Matawan show essentially the same fauna, and there is therefore no conflict between the paleontologic and stratigraphic evidence.

In all cases there is the ever present question of how much the beds may have been disturbed, and as the folding amounts to as much as 100 or 200 feet in the islands to the east, this is not always a negligible factor. In the wells on the south shore, as was early noticed by Woolman, the somber-colored lignite-bearing sands and clays are fair lithologic representatives of the Matawan, but in this region greensand must be almost entirely absent in the Matawan, for it is not represented in any of the samples from the wells of the Brooklyn waterworks or from any of the neighboring wells, the only suggestion of it being in the Pleistocene deposits in the Queens County well at Valley Stream (273) and at Long Beach (373), in both of which it occurs in coarse sand, evidently redeposited. This occurrence is so suggestive that it is confidently expected that fossiliferous greensand will be found in wells north and east of these localities.

The Cretaceous fossils found at different points in the drift at Brooklyn are also suggestive, though in all cases they are so separated from the Cretaceous beds that their real source can be only conjectured. They are perhaps Matawan, and may even be in part representatives of the occasional forms which are known to occur in the upper part of the Raritan.

On the north shore the beds in the same position as a rule more strongly resemble the underlying Raritan, though in the dark clays at Greenwood, Little Neck, West Neck (in the Ward well), and possibly at Elm Point, the darker beds are suggested. The sandy layers in part correspond to the Hazlet sands, but above the Matawan there is absolutely no similarity in the two sections. In place of from 250 to 450 feet of greensand marls there are sands and clays in no way different from the underlying beds which are known to be Matawan because of their lithologic character and position with relation to the Lloyd sand. Greensand beds have been reported only in the West Hills and in the Quogue and Bridgehampton wells, and in the latter cases there are some reasons for believing them similar to the Miocene greensands of Marthas Vineyard.[c]

So radical a change in the character of the deposits naturally raises the question of the cause. In some respects these light sands in the hills and the dark clays

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[a] See well No. 437, p. 281.

[b] Berry, E. W., Am. Nat., vol. 37, 1903, pp. 677-684; Bull. New York Bot. Gar., vol. 3, No. 9, 1903, pp. 45-103, pls. 43-57; Bull. Torrey Bot. Club, vol. 31, 1904, pp. 67-82, pls. 1-5.

[c] Bull Geol. Soc. Am., vol. 8, 1897, pp. 202, 203.

of the south shore above the beds regarded as Matawan suggest Miocene, but a comparison with the known position of the Miocene in adjacent areas renders this correlation very doubtful. It will be seen from fig. 4 and Pl. V that, so far as present knowledge goes, Long Island lies north of the main Miocene deposits, and that if the Miocene occurs at all it is to be expected as mere erosion outliers occupying the highest hills. Moreover, Mr. G. N. Knapp, who, by reason of his long and extensive field work in New Jersey, is well fitted to judge, has examined the beds in the Melville section (p. 20) and regards them as Cretaceous, with the possible exception of a thin layer between the upper gravel and the impure marl, which resembles Miocene. In order that any other portion of these beds may be Miocene, it is necessary to assume a much greater discordance of structure than is known to exist anywhere in this region between the Miocene and Cretaceous. These facts, with the agreement of the thickness of the beds below the Miocene (?) of the West Hill section with the thickness of the Cretaceous deposits of northern New Jersey, and the fact that Long Island is to be regarded as the normal continuation of New Jersey, both geologically and topographically, with the addition of a mantle of glacial deposits, throw the burden of proof on the person arguing for the Miocene age of these beds. The total absence of large greensand beds indicates a change in the local conditions. Perhaps the ancestral Hudson and Connecticut rivers may have had something to do with it; perhaps the ocean currents are responsible, for it is well known that both these factors tend to interfere with the formation of greensand, and glauconitic deposits are therefore seldom continuous over great areas.[a]

This sandy phase reappears on Marthas Vineyard above the basal plant-bearing beds, though at this point it contains fossils,[b] and while the data are not conclusive, they furnish further evidence of the change from the New Jersey conditions which is indicated on Long Island.

AGE OF THE RARITAN FORMATION.

After the early correlations, which were based on very meager data, the Raritan was referred to the Upper Cretaceous, and it was not until the work of Ward in connection with the much disputed Potomac group that it was referred to the Lower Cretaceous.[c] It was shown by Newberry[d] and Hollick[e] to be rather closely related to the Dakota and the Patoot and Atane beds of Greenland, all of which are regarded as Upper Cretaceous.

The work of Berry has now shown that there is no essential break between this fauna and that of the Cliffwood section, which is clearly Upper Cretaceous.[f]

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[a] Clark, W. B., New Jersey Geol. Survey, 1893, p. 225.

[b] Woodworth, J. B., Bull. Geol. Soc. America, vol. 8, 1897, pp. 199–200.

[c] Ward, L. F., The Potomac Formation: Fifteenth Ann. Rept. U. S. Geol. Survey, 1895, pp. 345–346; Age of the Island series, Sci., new series, vol. 4, 1896, pp. 757–760; Professor Fontaine and Professor Newberry on the age of the Potomac formations, Sci., new series, vol. 5, 1897, p. 420.

[d] Newberry, J. S., The flora of the Amboy clay, a posthumous work edited by Arthur Hollick: Monograph U. S. Geol. Survey, vol. 26, 1895, pp. 23, 33.

[e] Hollick, Arthur: Proc. Am. Assoc. Adv. Science, vol. 47, 1898, pp. 292–293; Science, new series, vol. 7, 1898, pp. 467–468; Am. Geol., vol. 22, 1898, pp. 255–256.

[f] Berry, Edward W., Plants from the Matawan: Am. Nat., vol. 37, pp. 677–684, 1903; Flora of the Matawan formation (Crosswick's clays): Bull. New York Bot. Gar., vol. 3, No. 9, 1903, pp. 45–103, pls. 43–57; Additions to the flora of the Matawan formation: Bull. Torr. Bot. Club, vol. 31, 1904, pp. 67–82, pls. 1–5.

Mr. David White informs me that he regards the Marthas Vineyard flora, on which Ward based his Island series, as essentially the same as the Cliffwood. The Long Island plant remains described by Hollick represent a horizon 100 or 200 feet above the Lloyd sand, and are therefore stratigraphically between the Amboy clays (Woodbridge, South Amboy, and Sayreville horizons) and the Cliffwood or basal Matawan. The stratigraphic sequence is, then, as follows: (1) Amboy clays; (2) Long Island red leaf-bearing concretions; (3) Cliffwood, Marthas Vineyard, East Neck.[a]

The few fragmentary marine remains obtained from the Lloyd sand at Lloyd Point are regarded by Stanton as Upper Cretaceous, and therefore confirm the general drift of the plant evidence, as do the molluscan remains (including *Exogyra*) reported by Woolman from a similar horizon in the Asbury Park well.[b] On the one hand marine fossils indicate the flora in the upper beds as clearly Upper Cretaceous; on the other, the flora shows that there is no essential break between the upper and lower beds of the Raritan. There is, however, a sharp floral break at the base of the Raritan[c] and it seems, therefore, necessary to return to the view of Newberry and regard the Raritan as basal Upper Cretaceous, and essentially equivalent to the Dakota and the Woodbine.[d]

SUMMARY OF THE CRETACEOUS.

The more important points relative to the pre-Pleistocene on Long Island may be briefly summarized as follows:

1. The bulk of the pre-Pleistocene deposits on Long Island are Cretaceous.
2. The basal beds are the stratigraphic equivalents of the Raritan, and are Upper Cretaceous.
3. The Matawan beds are apparently well represented, but their lithological character changes in going eastward.
4. No greensand beds comparable to the great greensand marl beds of New Jersey have been found, their stratigraphic position being occupied by fine lignitiferous sand with occasional clay beds.

TERTIARY.

GENERAL CONDITIONS.

Although there are no indications on Long Island of any break in the sedimentation during the Cretaceous, Doctor Clark has found in New Jersey evidence of perhaps two unconformities which indicate land periods of comparatively short duration.[e] It was, however, not until rather late Tertiary time that this region commenced to undergo the profound erosion which has given rise to the present land forms. These stages are imperfectly shown on Long Island, but in adjoining portions of the coastal plain the following major stages have been found: Late Pliocene (post-Lafayette) erosion, Lafayette submergence, early Pliocene erosion, Miocene submergence, Eocene erosion.

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[a] The East Neck locality is perhaps a little higher stratigraphically than the other two.
[b] Ann. Rept. N. J. Geol. Survey, 1895, pp. 72–75, 1896.
[c] Science, new series, vol. 4, 1896, p. 759.
[d] Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 7, 1901, pp. 318–322.
[e] Bull. Geol. Soc. America, vol. 8, 1897, pp. 328, 337–338.

EOCENE EROSION.

The absence of the greater portion of the Eocene in New Jersey indicates a period of elevation, but the absence of any great unconformity between the Cretaceous or Eocene and the Miocene strata indicates that either this elevation was slight or that the period was of such a duration that the land was essentially base-leveled.

MIOCENE SUBMERGENCE.

While the deposits of the Miocene were clearly very thick toward the sea and thin toward the land, the exact position of their landward edge is uncertain.

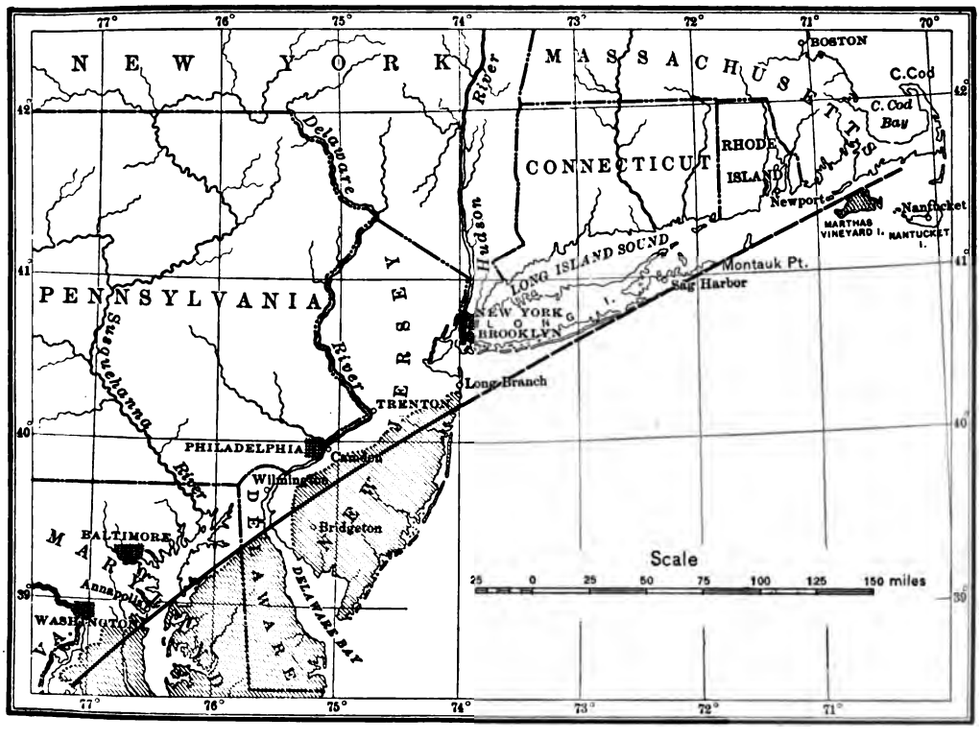


FIG. 4.—Sketch map showing known distribution of the Miocene near Long Island. Shaded area is underlain by Miocene. Heavy black line gives general direction of strike and shows approximate point at which base of Miocene reaches sea level.

It may, however, be regarded as reasonably certain that over most of the Atlantic coastal plain they were of sufficient extent and thickness to obliterate the low features developed in the underlying Cretaceous and Eocene beds during the preceding erosion period.

Distribution of Miocene deposits.—In the Long Island region and in the New Jersey region the Miocene sediments were deposited under similar conditions, and as these two areas have been subjected to the same forces, except glacial action, their distribution in both should be similar. The only bed thus far seen on Long

Island which is regarded as possibly Miocene is a thin bed of "fluffy sand" which Mr. G. N. Knapp recognized in the upper part of the Melville section (p. 20), and which is the counterpart of certain sands occurring in the Miocene of New Jersey. A comparison of the sections shown in Pl. V indicates that if the structure is normal, and there is every reason to believe it is, a Miocene outlier should be expected at this point. The same evidence shows the absence of the Miocene above sea level (fig. 4 and Pl. V) on southern Long Island, except possibly along a portion of the South Fluke. This line of argument is important, for it shows that the Tertiary deposits can not be expected on the north shore any more than in the Hightstown Vale (p. 30) in New Jersey, and that the occurrences on Long Island are probably limited to erosion outliers, with the embed beneath the Atlantic.

EARLY PLIOCENE EROSION.

In the succeeding erosion period the first forerunners of the present topography were developed. Erosion was active, the mantle of Miocene beds was partly removed and the underlying Cretaceous exposed near the old shore line.

LAFAYETTE SUBMERGENCE.

During Lafayette time the rather low topography developed in this region was buried by a mantle of littoral deposits. The smaller depressions were obliterated but the broader features persisted.

LATE PLIOCENE (POST-LAFAYETTE) EROSION.

After the Lafayette submergence there was a long period of erosion in which the land stood relatively high and the essential features of the present topography were developed.

DEVELOPMENT OF TOPOGRAPHIC FEATURES.

The most pronounced topographic feature resulting from or accentuated by the early and late Pliocene erosion epochs is a more or less persistent line of hills overlooking a landward depression which extends from the Mannetto (West) and Wheatley hills on Long Island through the highlands in the coastal plain of New Jersey and Maryland to the Potomac River near Washington. Such a degradational feature is common in all regions of gently inclined rocks of unequal hardness. By weathering and erosion the softer beds are removed and the more resistant ones stand out as chains of hills. Marked topographic forms depending on these factors extend over wide areas and it seems desirable to have distinctive topographic terms for them.

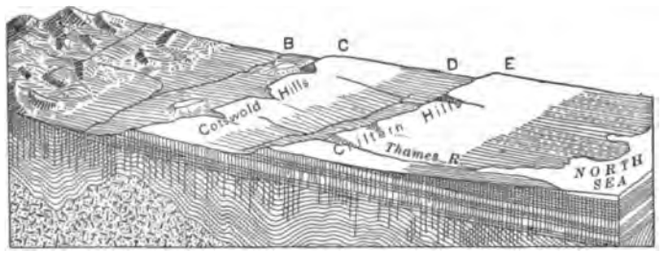


FIG. 5. Stereogram of eastern England (after Davis), showing the development of wolds and vales. B, D, vales; C, E, wolds.

Fortunately names are readily obtainable by analogy with eastern England where, in the gently sloping rocks of the post-Paleozoic series, similar features are well developed (fig. 5). There the ranges of hills are in many places called wolds—as the Cotswold Hills and the Lincolnshire and Yorkshire wolds—and the accompanying longitudinal depressions have been termed vales—as the vales of Pickering, Blackmore, White Horse, Red Horse, Pewsey, and Wardour. These terms are, therefore, appropriate for lines of hills and parallel valleys of a similar

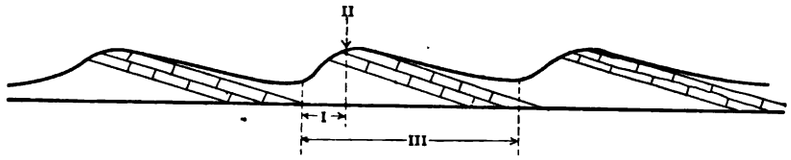


FIG. 6.—Diagram showing the three uses of "escarpment" as applied to topographic features.

type and origin. As a definite physiographic term wold may then be defined as a range of hills produced by differential erosion from inclined sedimentary rocks, and vale as the accompanying depression or strike valley (fig. 7).

Wold has, so far as the writer is aware, never before been used as a distinct term for a definite topographic form, but vale has been extensively employed by Woodward in describing the longitudinal valleys in eastern England.[a]

As a geographic term, vale, although generally applied to these strike valleys, has occasionally been used for valleys of other origin—as the Vale of Eden, in Westmoreland and Cumberland, in which a portion of the depression has been

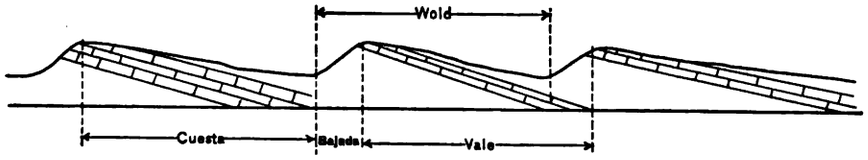


FIG. 7.—Diagram showing relations of wold, vale, cuesta, and bajada.

produced by faulting[b]—but these may be regarded as exceptional cases, and the word used in a physiographic sense as the direct antithesis of wold, or wolds, without confusion.

To the feature here defined as a wold, the term escarpment has often been applied, but, as already pointed out by Davis,[c] this usage is objectionable, for when escarpment is used for the whole hill feature it is given a meaning quite different from that usually associated with it. It is commonly used for a very steep declivity or cliff,[d] but has been extended to mean: (1) The steeper slope of a

[a] Woodward, Horace B., The Jurassic rocks of Britain: Memoirs Geol. Survey Gt. Brit., vol. 3, 1893, pp. 309–313; vol. 4, 1894, p. 459; vol. 5, 1895, p. 297. The geology of England and Wales, 1887, p. 599.

[b] Marr, John E., The scientific study of scenery, London, 1900, p. 113. Ramsey, A. C., Physical geology and geography of Great Britain, 6th ed., 1899, pp. 362–363, fig. 129.

[c] Proc. Geol. Assoc. Lond., vol. 16, 1899, p. 77.

[d] Geikie, Archibald, Text-book of geology, vol. 2, 1903, p. 13. Example cited: The face of a mesa.

wold;[a] (2) the top or crest line of a wold;[b] (3) the whole hill feature—exactly synonymous with wold (fig. 6).[c]

The word cuesta is used in the southwestern United States for a sloping plain which is terminated on one side by a steep slope.[d] It seems to have no relation to structure, but only to topographic form, and while the long slope of a wold, or dip slope, is a cuesta, a cuesta is not always a dip slope. The word has been applied by Davis to many of the dip slopes of wolds in the United States, and has been extended by him to include the whole topographic form, with the remark that while there may be objection to this use of the word it will, until a better name is suggested, serve a useful purpose.[e] Cuesta should doubtless be restricted to its original usage, and apply only to the gently sloping plain. A name for the shorter slope or inface can likewise be obtained in the same region in the companion terms to cuesta of *ceja* and *bajada*, the first referring to an escarpment and the second to "a gradually descending slope as distinguished from a more vertical escarpment."[f] Bajada would then be applied where there is no escarpment or where the escarpment feature was an insignificant portion of the whole slope; while ceja would be applied where the scarp forms the major part of the boundary between two successive cuestas (fig. 7).

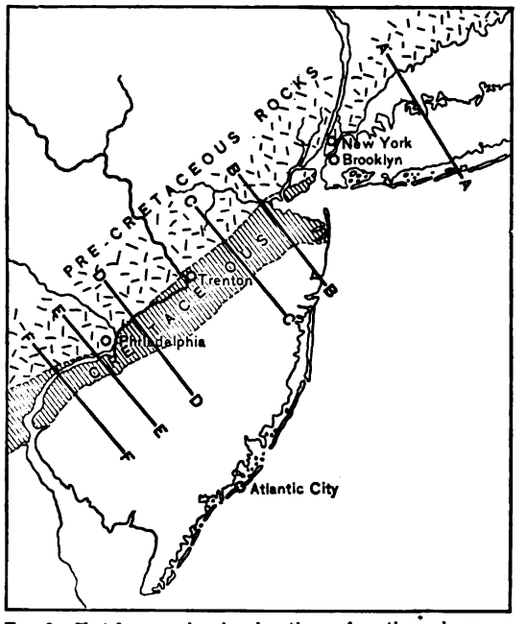


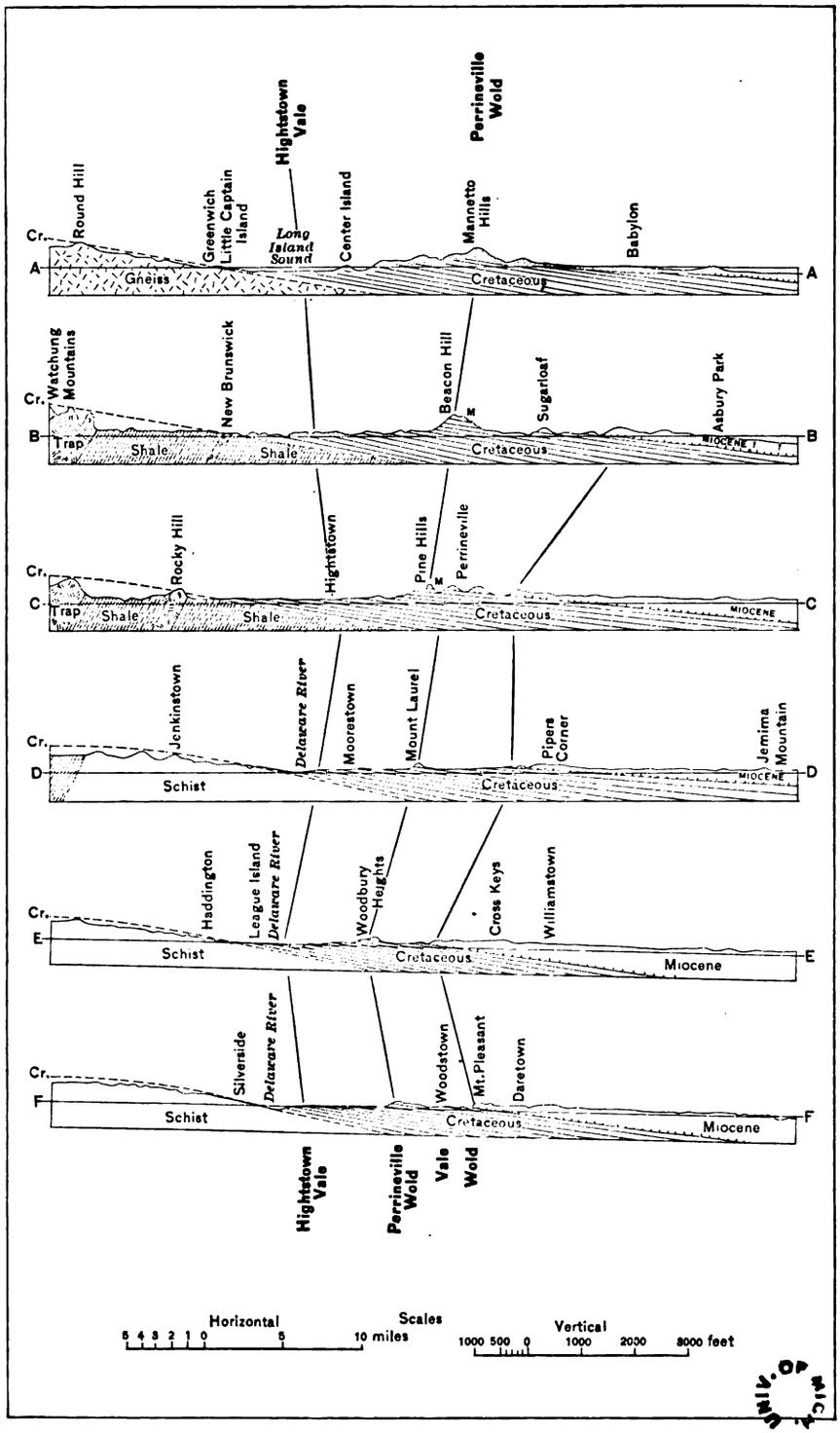
FIG. 8.—Sketch map showing locations of sections shown on Pl. V.

WOLDS AND VALES.

In the coastal plain of New Jersey there is a well-marked vale and wold (Pl. V) and a less perfectly developed pair. The innermost vale may be traced more or less continuously from the Potomac River near Washington to northern Long Island, and perhaps to southeastern Massachusetts; in it are found Long Island Sound and the northeast and southwest portions of the Delaware, Susquehanna, and Potomac rivers. Through New Jersey it is particularly well marked, and may be named the Hightstown Vale, from Hightstown, in Mercer County, where it is typically developed (Pls. II and V, *C*).

Coastward of the Hightstown Vale and overlooking it is a range of rolling hills, highest to the northeast at Beacon Hill and Telegraph Hill, N. J., and Mannetto Hills,

[a] Harrison, W. Jerome, Geology of the counties of England, 1882, p. 344. Geikie, James, Earth sculpture, 1898, p. 58, fig. 15.
[b] Marr, John E., The scientific study of scenery, 1900, p. 117.
[c] Geikie, James, Earth sculpture, 1898, pp. 65, 70, fig. 23. Woodward, Horace B., The geology of England and Wales, 1887, p. 599; The Jurassic rocks of Britain: Memoirs Geol. Survey of United Kingdom, vol. 4, 1894, p. 459; ibid., vol. 5, 1895, p. 297.
[d] Hill, R. T., Description of topographic terms of Spanish America: Nat. Geog. Mag., vol. 7, 1896, p. 295.
[e] Davis, W. M., The drainage of cuestas: Proc. Geol. Assoc. London, vol. 16, 1899, pp. 76, 77.
[f] Nat. Geog. Mag., vol. 7, 1896, p. 297.



COMPARATIVE CROSS SECTIONS OF LONG ISLAND AND NEW JERSEY ALONG LINES SHOWN IN FIGURE 8, SHOWING RELATIONS OF THE TOPOGRAPHIC FEATURES.

By A. C. Veatch, 1904.

Dotted portion of sections A–A and B–B represents Pleistocene deposits. Broken line marked Cr. shows pre-Cretaceous peneplain.

17110—No. 44—06—3

Long Island, but gradually becoming lower and of less importance topographically to the south. This range of hills is typically developed at Perrineville, in Monmouth County, N. J., 5 or 6 miles east of Hightstown, and is, therefore, named the Perrineville Wold. Both the Hightstown Vale and Perrineville Wold have been produced by the differential erosion of Cretaceous strata. Of the minor and but partly developed vale and wold to the east of the Perrineville Wold little need be said at this time, except to point out their general resemblance to the major topographic features of this type.

DEFLECTION OF RIVERS IN HIGHTSTOWN VALE.

In studying the abnormal deflection of the rivers in the Hightstown Vale it is necessary to commence with the uplift which marked the beginning of the post-Miocene erosion cycle. At that time the streams issuing from the valleys of the older land followed the retreating sea directly across the emerging coastal plain and adapted themselves to its minor irregularities and gentle slope (Pl. VI, *A*). During this period, in the region north of Virginia, the streams near the landward edge of the Miocene rocks cut through the Miocene and reached the Cretaceous. The soft basal Cretaceous rocks were more easily eroded than the overlying ones, and a shallow vale, overlooked by a low, northwest-facing wold broken by the transverse or dip valleys of the main streams, was developed parallel to the old shore line. This ancestral Hightstown Vale and Perrineville Wold was farther inland than to-day and, though not prominent, was doubtless well marked.

In the succeeding Lafayette submergence a mantle of littoral sediments was spread over the coastal plain. The narrow transverse valleys through the wold (fig. 5) were more nearly obliterated by this mantle than the broad vale, and when the land was again elevated the ancestral Connecticut, Delaware, Susquehanna, and Potomac rivers discharged into a slightly depressed trough. Had there been no tilting in either direction in this uplift these rivers would have overflowed the barrier afforded by the wold and the more or less completely filled, narrow, transverse valleys and cut new channels directly to the sea; but if there was tilting in either direction the rivers would have flowed down the vale in direction of the tilting and finally escaped seaward through the partly filled depressions of lower transverse stream valleys. As these streams were favored by softer strata and by greater volumes, they maintained their ascendancy over the smaller streams which developed east of the crest of the Perrineville Wold, and so persisted in their deflected courses (Pl. VI, *B*).

In much of Virginia and North Carolina where the more recent deposits overlying these Cretaceous beds have not been removed, no such deflection of the rivers occurs; but in Alabama where this mantle is no longer present the Coosa is deflected into an east-west course at the point where it leaves the older land; farther north the Tennessee is deflected under conditions very similar to those on the North Atlantic coast.

Two other explanations have been offered for this deflection, the first by McGee,[a] and the second by Darton.[b] In the first the deflection is attributed to faulting and in the second to the action of coastal bars. In the first case it must be regarded as a

[a] McGee, W J, The geology of the head of Chesapeake Bay: Seventh Ann. Rept. U. S. Geol. Survey, 1888, pp. 616–634.

[b] Darton, N. H., Jour. geol., vol. 2, 1894, p. 581; also Newsom, J. F., The effect of sea barriers upon ultimate drainage: Jour. Geol., vol. 7, 1899, pp. 445–451.

very strange coincidence that a fault should follow the curved line of strike of the Cretaceous when this is not parallel to the mountain chains and produce a valley just where a vale should be produced by differential erosion. Moreover, the rock surface beneath the plain and the remnants of the old surface preserved in the crests or flat tops of the hills through New Jersey show no break such as would have been produced by a fault.

Darton's explanation was proposed when further field work had proved the nonexistence of this hypothetical fault, and was based on the prevailing southward drift of the sands of the Atlantic coast. This is assumed to have prevailed since early Cretaceous time, and to have produced the ultimate deflection of the rivers by building spits or bars along the shores. There are two objections to this hypothesis: (1) it does not explain why the deflection is confined to the outcrop of the soft layers of the Cretaceous—why it does not extend continuously southward through the coastal plain, but reappears when the Cretaceous is again exposed; (2) all the coastal bars now

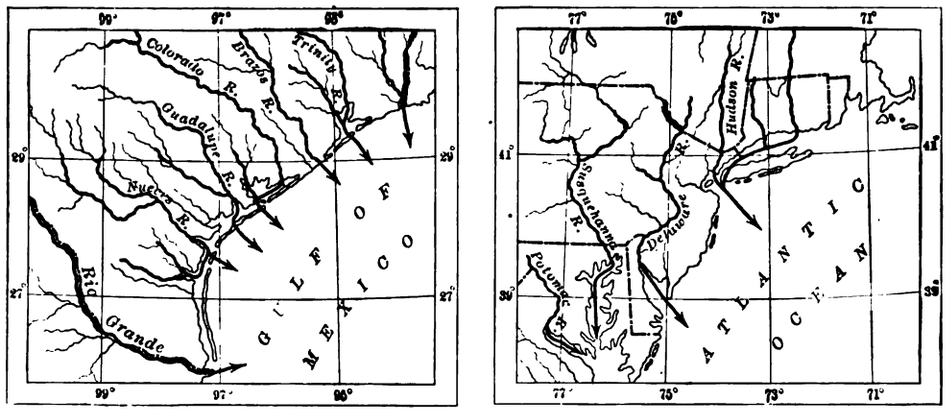
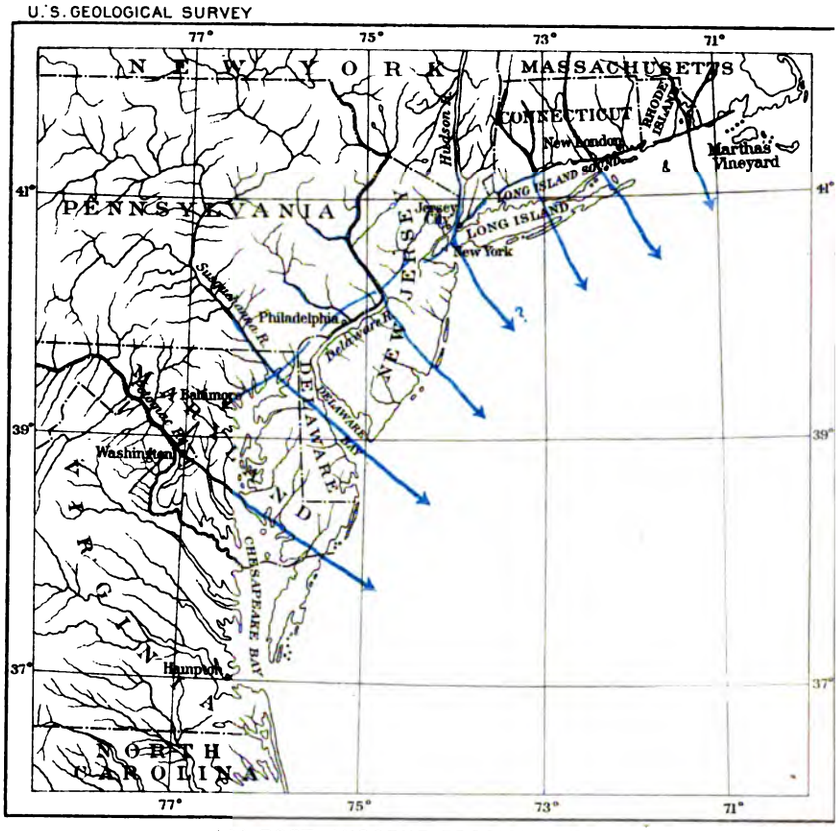


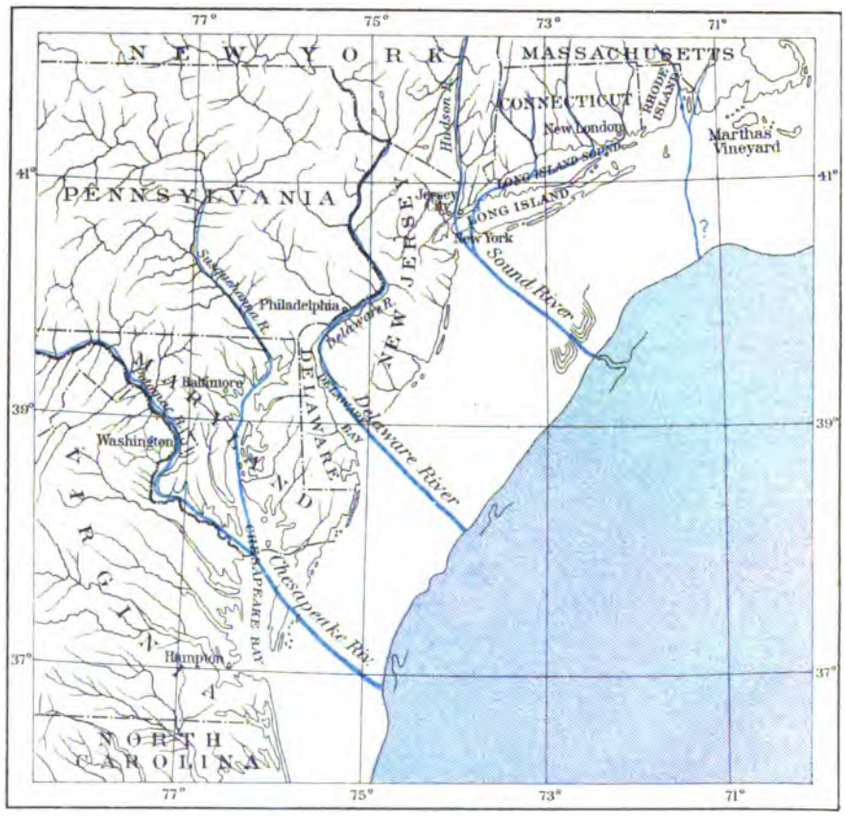
FIG. 9.—Comparative maps showing deflection of streams in the Hightstown Vale and the deflection which would be produced by the large Texas bars if the land were elevated.

forming are cut by important breaks, or tidal guts, and while these might, if the land were elevated, produce minor deflections under certain favorable conditions, they could not cause deflections of this magnitude, and the deflections would not have the same uniformity in direction. The long Texas bars offer, perhaps, the closest analogy to hypothetical bars necessary for the diversion of these northern rivers, both in the length of the bars and the size of the rivers discharging into the coastal lagoon behind them. However, careful study of the Coast Survey charts shows that where the rivers are carrying a moderate amount of sediment, as the Brazos and the Rio Grande, they have extended their mouths to the coastal barrier, and that where they are not so laden there is always a deep channel or tidal gut in the bar so situated that the deflection on elevation would be comparatively small. The comparatively insignificant effect that these bars would have in case the land were elevated is shown in fig. 9. Rivers may be deflected, as in the case of the Colorado, but it is regarded as extremely improbable that they could be deflected to the extent and with the regularity of the rivers in the Hightstown Vale.

U.S. GEOLOGICAL SURVEY



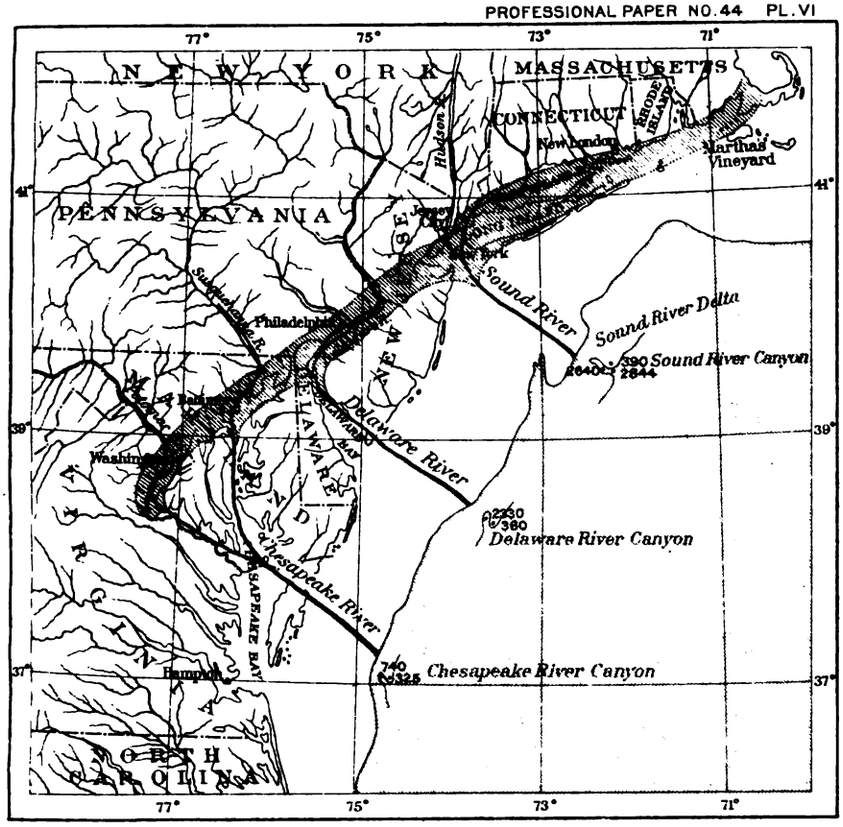
(A) POST-MIOCENE EROSION INTERVAL



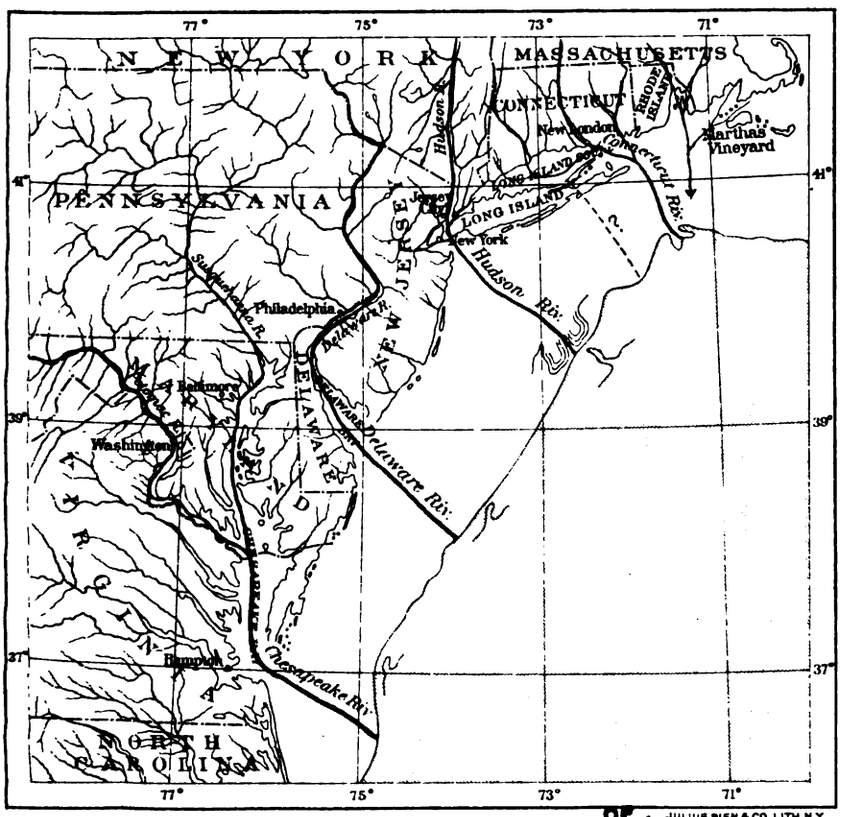
(C) POST-MANNETO EROSION INTERVAL

DEVELOPMENT OF MAJOR DRAINAG
BY A

100 50 25 0



(B) POST-LAFAYETTE EROSION INTERVAL



(D) VINEYARD EROSION INTERVAL

JULIUS BIEN & CO. LITH. N.Y.

LEGEND

Present drainage and shore lines

Former drainage and shore line

Canyons of the coastal shelf

Cretaceous outcrops

390

Soundings in feet below present sea level

E OF NORTH ATLANTIC COASTAL PLAIN

VEATCH

1904

Scale

100 200 300 miles

QUATERNARY.

While during the Cretaceous and Tertiary the portion of the Atlantic coastal plain between Cape Hatteras and Nantucket was subjected to very nearly the same conditions and the development was therefore the same in both periods, in the Quaternary new factors arose which affected only the region from Long Island eastward, and gave to it a surficial aspect differing decidedly from that of the other portions of the coastal plain to the south. Although the several ice advances directly affected Long Island and the region eastward, none of them reached the coastal plain of New Jersey and Maryland, and here the only records of Pleistocene time are therefore the terraces formed in such positions that they were not destroyed by subsequent submergences.

In the region affected by the glaciers the following divisions of the Pleistocene have been recognized:

TABLE II.—*Pleistocene formations on Long Island.*

Division.	Characterization.
Wisconsin stage. Late: Harbor Hill Moraine. Early: Ronkonkoma Moraine.	Glacial: Formation of two lines of terminal moraines, with accompanying outwash and kettle plains.
Vineyard interval	Interglacial: Elevation of land 150 to 200 feet above the present sea level, and profound erosion of Tisbury.
Tisbury stage	Glacial: Depression 200 to 250 feet below sea level, and formation of great deposit of outwash sand and gravel.
Gardiner interval	Interglacial: Land somewhat lower than to-day; erosion of folds produced by the Gay Head folding.
Gay Head folding	Glacial: Folding of surficial portions of all older formations.
Sankaty stage	Interglacial: Formation of clay and sand beds with land slightly above the present sea level.
Jameco stage	Glacial: Partial filling of Sound Valley in western Long Island, and deposition of gravel with large bowlders on Gardiners and New England islands.
Post-Mannetto and pre-Jameco erosion	Interglacial: A long erosion period, with land about 300 feet above the present sea level.
Mannetto stage	Glacial: Depression of 300 feet; deposition of old gravel in West and Wheatley hills.

MANNETTO GRAVEL.

CONDITIONS OF DEPOSITION.

Following the long post-Lafayette erosion epoch, when the drainage was approximately as shown in Pl. VI, *B*, the land was submerged to a depth of about 300 feet at Long Island, and a mantle of gravel and loam spread over the irregular surface developed during the Tertiary.

CHARACTER OF DEPOSITS.

In this region these deposits are for the most part composed of quartz gravel, but contain also some very much decayed pebbles and bowlders of probable glacial origin, in which respect they agree with the earliest Pleistocene deposits which Salisbury has recognized in New Jersey.

PRESENT DISTRIBUTION.

Because of the destructive and reconstructive effects of the succeeding periods the deposits of this age are now recognizable, as a rule, only in the higher levels, and the typical examples on Long Island are, therefore, on the highest hills of the pre-Pleistocene, as in the Mannetto (West) and Wheatley hills, from the first of which the formation has been named.

POST-MANNETTO AND PRE-JAMECO INTERVAL.

Following the deposition of the Mannetto gravel the land was again lifted, this time to a height of something of over 250 feet, and the work of the preceding erosion epochs was continued. The Mannetto deposits were to a large extent removed and the valleys somewhat deepened.

JAMECO GRAVEL.

CONDITIONS OF DEPOSITION.

The ice sheet, again advancing, appears to have about reached the present north shore of Long Island, and to have extended well down toward Block Island and Marthas Vineyard. On western Long Island the Sound River Valley (Pl. VI) offered a natural outlet for the detrital-laden streams issuing from the ice front, and as the land probably stood somewhat lower than in the preceding erosion epoch, the old valley was partly filled with highly erratic sand and gravel (fig. 10). This glacial débris was deposited along the north shore and in the region to the east, but not south of the nucleus of older upland. The deposits are then thickest in and near the old valley; they are poorly developed on the south shore east of this valley, but reappear in force on eastern Long Island and the islands to the east, where they have been brought up by folding.

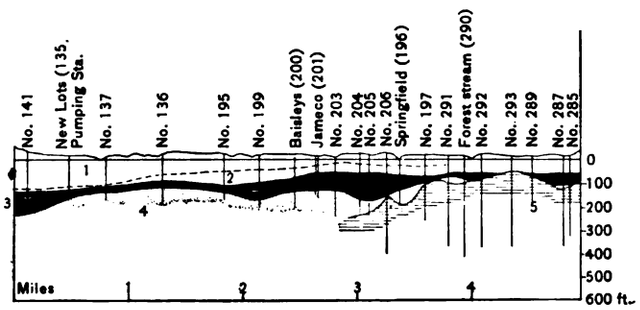


FIG. 10.—Section from near Ridgeway, Brooklyn, to Valley Stream, showing position of (1) Wisconsin, (2) Tisbury, (3) Sankaty, (4) Jameco, (5) Cretaceous beds, and the east side of the Sound River Valley. Figures correspond with those used in Pl. XXIV and in Chapter IV.

CHARACTER OF DEPOSITS.

In western Long Island the Jameco gravels consist of dark-colored sands and gravels that vary considerably in coarseness and are distinguished by the small per-

centage of quartz which they contain. Even the surface gravel, which represents the outwash when the ice was but a few miles to the north, contains a very much higher percentage of quartz; the only gravel beds on the island resembling these occur in the Wisconsin deposits in and north of the moraine. So pronounced was the glacial character of these old gravels that when they were first examined it was thought they surely represented surface Wisconsin deposits, and that some careless clerk had inverted the tube and labeled it upside down;[a] but this theory became untenable as well record after well record was examined, and all, in certain regions, showed the following succession:

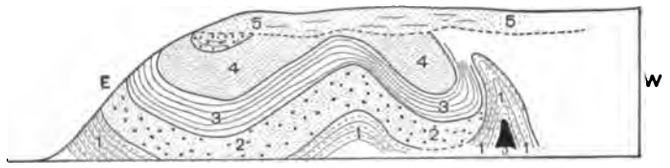


FIG. 11.—Section near middle of northeast shore of Gardiners Island, N. Y.; (0) black Cretaceous clay; (1) fine gray micaceous sand (Cretaceous); (2) Jameco gravel; (3) red clay (Sankaty); (4) silty sand (Sankaty); (5) Wisconsin till and outwash gravel. Height of section, 60 feet.

Geologic succession in wells in western Long Island.

1. Quartz sand and gravel with a noticeable percentage of erratic material (Wisconsin).
2. Quartz sand, gray or yellow, with little if any material of recognizable glacial origin (Tisbury).
3. Blue clay with wood (Sankaty).
4. Dark, multicolored, highly erratic gravel (Jameco).

East of this valley and the delta-like extension at its opening the only representatives of this period are the normal coastal sands and gravels similar to the beds above and below, and seldom separable from them.

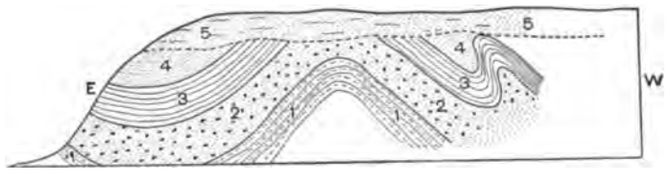


FIG. 12.—Section on west side of hollow which afforded the section in fig. 11, about 200 feet farther west. The numerals indicate same beds as in fig. 11.

At Gardiners Island and on Marthas Vineyard the percentage of fine, yellow, gravel is much greater, and the beds contain very large bowlders of compound quartz crystalline rocks, indicating the nearness of the ice. These beds, which are here brought up by folding, are likewise separated from the younger gravels by the clay deposits of the Sankaty (figs. 11, 12).

PRESENT DISTRIBUTION.

On the north shore the Jameco beds have been considerably eroded and disturbed and are not always readily separable from the succeeding deposits. Occasional remnants of considerable local importance as sources of water supply, however, have been encountered, as indicated in the well records.

On the south shore where the Jameco beds have not been eroded and are typically developed in the region of the old valley (fig. 10) they form one of the most important water horizons of the island.

[a] The samples of the borings of the Brooklyn waterworks are preserved in the Municipal Building, Brooklyn, N. Y., in glass tubes representing miniature reproductions of the borings.

SANKATY FORMATION.

CONDITIONS OF DEPOSITION.

The effect of the Jameco epoch was to partly fill the Sound Valley on western Long Island and to spread a relatively thin cover of gravel and sand over the areas not in the lee of the old land masses. With the continuance of the progressive subsidence, which appears to have begun near the close of the post-Mannetto erosion interval, the coarser beds of the Jameco were succeeded by finer sediments, and as the ice retreated, temperate water forms similar to those living to-day occupied the waters. The land stood about 50 feet higher than to-day, and there existed an ancestral Long Island rudely resembling the present island. The beds forming near its shore were predominantly swampy and in many ways similar to those accumulating on a minor scale at present. These swamp conditions gave place in deeper water to more truly marine ones, where marine forms were included, in greater or less numbers, in the sediments deposited.

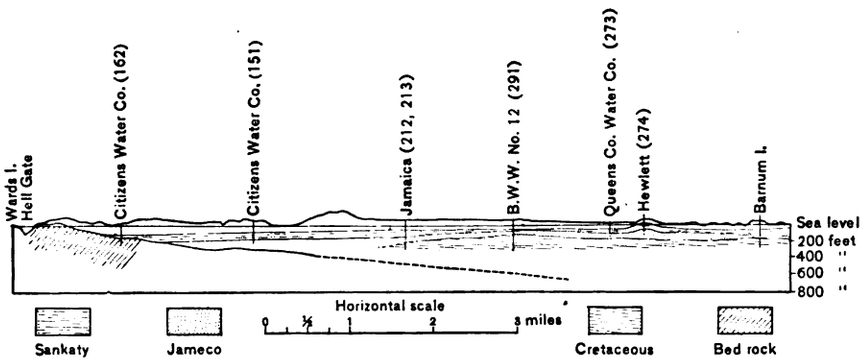


FIG. 13.—Section from Wards Island to Barnum Island, showing fold at Rockaway Ridge (Hewlett), and the relations of the Sankaty, Jameco, Cretaceous, and "bed rock." Figures correspond to those used on Pl. XXIV and in Chapter IV.

CHARACTER OF DEPOSITS.

These sediments therefore vary from truly swampy deposits on the one hand to relatively fine sands and clays, which show no trace of swamp origin, and which contain shallow-water mollusks on the other; thus on western Long Island, where the partly filled channel of the Sound Valley favors the formation of swamp deposits, there are irregular beds of dark-colored clay (figs. 10, 13), containing considerable lignite and lignitized wood, occasional lenticular beds of silty sand and gravel from 5 to 10 feet thick, and, toward the coast, a few marine shells. On the other hand, the beds of this age on Gardiners Island (figs. 14, 15), which have been brought up by folding, were formed farther from the shore, contain no lignitic material, and carry a good molluscan fauna. In general this formation is about 50 feet thick, although some of the Brooklyn waterworks test borings show a thickness of 150 feet near the axis of the old valley.

PRESENT DISTRIBUTION.

The Sankaty deposits, like the Jameco, occur on the north shore merely as erosion remnants, more or less disturbed by folding, and associated with some-

what similar Cretaceous deposits. They afford some of the local clay layers which are the retaining layers in some of the shallow north shore artesian wells (fig. 16).

On the south shore these beds are most typically developed in the region of the old valley, where they form the retaining layer for the water in the Jameco gravels (fig. 13). East of Springfield they are less typical, although well developed at the Queens County Water Company's plant and under Rockaway Ridge. Their presence is suggested by the silty clays overlying the artesian horizons at a number of the Brooklyn plants east of Millburn.

GAY HEAD FOLDING.

DESCRIPTION.

The exact conditions immediately following the deposition of the Sankaty are not known, but there is no evidence indicating that the relative positions of

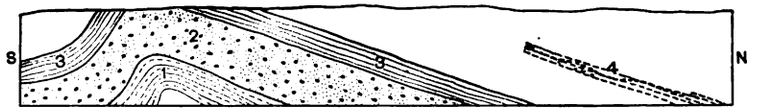


FIG. 14.—Section at Tobacco Point, east side of Gardiners Island, N. Y. 1, Cretaceous; 2, Jameco gravel; 3, red clay (Sankaty); 4, fossil bed with bowlders (Sankaty). Height, 20 feet; length, 1,200+ feet. Surface beds omitted.

the land and sea were materially changed. The increasing sandiness of the upper part of the Sankaty on Gardiners Island suggests a slight change from the progressive subsidence which began in the post-Mannetto interval, but the change was not of a very great order. The important and distinctive feature of this period is the wonderful folding and disturbance of the beds along the north shore of Long Island and the islands eastward. These folded and faulted strata can now best be seen at Gay Head on Marthas Vineyard (fig. 17) and on Gardiners Island (figs. 11, 12, 14, 15). At Gay Head Woodworth has very carefully worked out a section showing a deformation of more than 200 feet and a wonderful series of closely compacted folds and faults. On Gardiners Island the folds are as complicated as on Marthas Vineyard, and the opportunities for study even better. It is regarded as particularly unfortunate that time was not available in which to work out the detailed maps and sections, which are urgently needed at this locality. At present

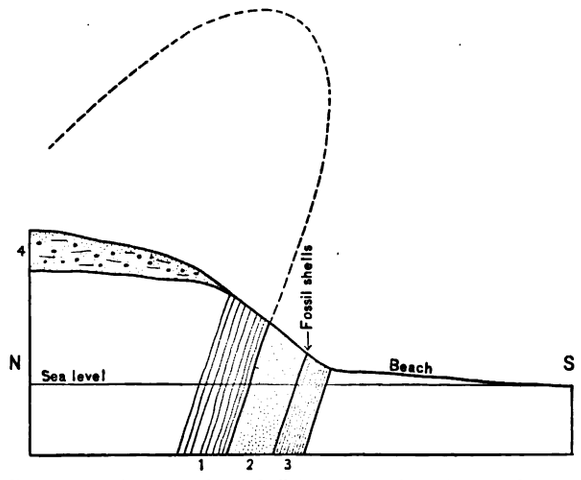


FIG. 15.—Section near Cherry Hill Point, Gardiners Island, showing location of fossil-bearing stratum. 1, Laminated red clay and sand; 2, mottled-gray, brown, and yellow sand; 3, dark, yellowish-brown, silty clay; 4, till. 1–3 are Sankaty; 4 is Wisconsin.

it can only be stated that while the axes of a series of adjacent folds are generally parallel, they are not parallel to the axes of a series at no very great distance. Thus, near the center of the northeast shore a series of four folds was seen whose axes are N. 20° W., while a little farther east, near Eastern Plain Point, the axis of three or four sharp overturned folds is almost due east and west.

Ries observed a similar folded structure on Fishers Island, where excavation has shown that the folding does not extend downward over 20 or 30 feet.[a] On Long Island, near Orient, Mather observed the same phenomena (fig. 18) and noted their superficial character.[b] Some folding and disturbance of strata can be observed in nearly all of the outcrops of the older beds on the north shore, among which should be noted particularly those near Lloyd Beach in Cold Spring Harbor, at the southern end of Center Island, and at Glen Cove and Sea Cliff. In these regions well borings have clearly shown that the folding is entirely superficial (Pl. II, fig. 16).

CAUSE OF FOLDING.

In studying the cause of this folding four principal points need to be considered: (1) As the folding involves glacial deposits, it is clearly Pleistocene; (2) it is essen-

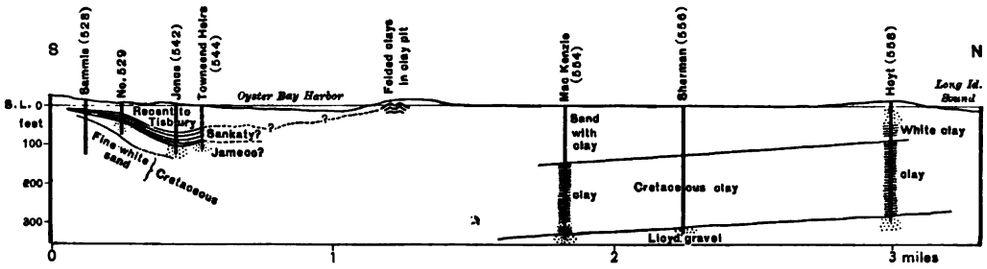


FIG. 16.—Cross section through Oyster Bay and Center Island, showing relations of clay and water-bearing horizons encountered in the Oyster Bay wells to the Cretaceous clays and Lloyd gravel in the Center Island wells.

tially superficial and, therefore, can not be of orogenic origin; (3) it occurs wholly in a glaciated region, other portions of the coastal plain showing no analogous phenomena; (4) the general direction, as well as the local irregularities of the folds, are such as would be expected from ice thrusts. To account for these folds three theories have been advanced: (1) That they are due to landslips;[c] (2) that they were formed by mountain-building forces;[d] (3) that they were produced by the lateral shove of a continental ice sheet.[e]

It is well known that landslip or hill creep can produce local disturbances of considerable importance, and these phenomena may be observed to-day in all bluff sections or steep slopes in this region, particularly at the Broken Grounds or Ragged Ground near Fresh Pond, north of Northport (Pl. VII). At these places, however,

[a] Bull. New York State Mus. No. 35, 1900, p. 603.

[b] Geology of the First District, 1843, pp. 249, 259.

[c] Mather, W. W., Report of the first district, 1843, p. 249. Dana, Manual of Geology, 1895, p. 1021.

[d] Shaler, N. S., Seventh Ann. Rept. U. S. Geol. Survey, 1888, pp. 343-347; Bull. Geol. Soc. Am., vol. 5, 1894, pp. 199-202; Bull. Geol. Soc. Am., vol. 6, 1895, p. 7. Dana, Manual of Geology, 1895, p. 934.

[e] Merrill, F. J. H., Proc. Am. Assoc. Adv. Sci., vol. 35, 1886, pp. 228-229. Hollick, Arthur, Trans. New York Acad. Sci., vol. 13, 1894, p. 123; Bull. Geol. Soc. Am., vol. 6, 1895, pp. 5-7. Ries, Heinrich, Bull. New York State Museum, No. 35, 1900, p. 603.

LANDSLIPS DUE TO PARTIAL UNDERMINING OF CLIFF FACE BY OCEAN AT THE BROKEN GROUNDS, OR RAGGED GROUND, NEAR FRESH POND, NORTHEAST OF HUNTINGTON, NORTH SHORE OF LONG ISLAND.

Photograph by Edward P. Buffet.

the folding is essentially local, and presents neither the characteristics nor the magnitude of the occurrences at Gardiners Island, Block Island, and Marthas Vineyard, where the materials have been forced up—not let down. Moreover, no analogous foldings occur in the southward extension of the coastal plain beyond the limits of ice action.

The theory of orogenic origin is not only ruled out by the superficial character of the folding, but has other insurmountable objections.

FIG. 17.—Cross section at Gay Head, Marthas Vineyard. After Woodworth. A, Cretaceous; B, Miocene, with probably Pliocene; C, Jameco and Sankaty; D, thrust planes and faults. Surface morainal deposits omitted. Height, 120 feet; length, 1 mile

The only hypothesis which explains all of the phenomena observed is that the folding was produced by the thrust or drag of a continental ice sheet. As the major portion of the folding occurred at one time, or in the same epoch, and

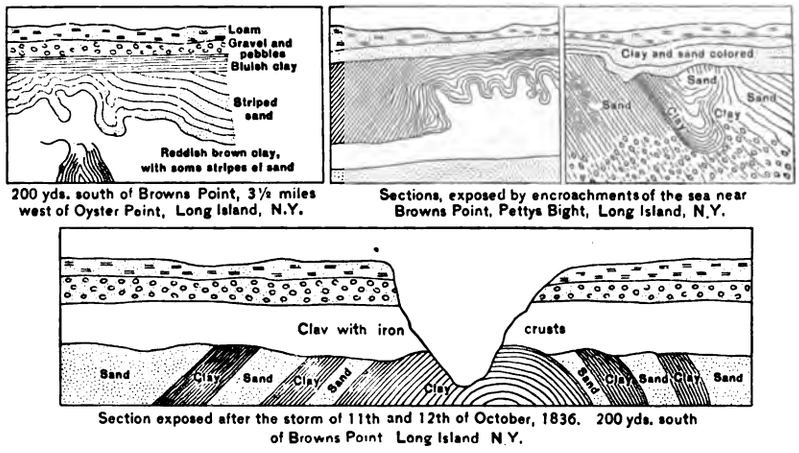


FIG. 18.—Sections exposed at Browns Point after storm of October 11 and 12, 1836. After Mather, 1843.

as later deposits show only minor disturbances, it is necessary to suppose that the conditions were more favorable during the Gay Head stage than during the Wisconsin stage, which is the only other advance which approached this one in extent. Among the conditions which may have been effective in producing this difference in results, the following may be enumerated: (1) The ice producing this folding extended farther south than any previous advance, and therefore was resisted by more of the original irregularities of the surface; (2) the clayey character of the strata against which it pressed was particularly favorable for the production and preservation of the folds, while before the Wisconsin all the older beds had been covered with a heavy mantle of Tisbury gravels which did not lend themselves so readily either to deformation, or the preservation of records of deformation.

In the two most noted examples of disturbance by glacial action in Europe—the Norfolk Cliffs in England, and the cliffs of the islands of Möen and Rügen[a] in Denmark and Germany—the conditions were very similar to those in this region. The ice, coming from the harder, pre-Cretaceous rocks, passed across a depression, which may have been filled with water, and, impinging against the higher upper Cretaceous beds covered with glacial sands and clays of a former advance, produced very remarkable dislocations and contortions. The Cretaceous chalk, being more brittle than the Cretaceous clays of the coast of the United States, was more often broken, and great masses were pushed up bodily and commingled with the glacial beds.

The same suggestions of origin have been proposed for these European ice-made folds and faults, with the addition, in England, of an iceberg hypothesis. This theory, first proposed by Lyell,[b] was widely adopted in England, and it was not until the extended, careful work of Reid that it was shown to be untenable.

GARDINER INTERVAL.

After the Gay Head folding the tops of the folds were truncated. While this truncation might be produced by the overriding of the ice, the exposures on Gardiners Island show no evidence that it was accomplished in this manner. The truncation is clean, not dragged as it would be if it had been produced by ice, and bears all the aspects of having been produced by water erosion. Woodworth has arrived at a similar conclusion from a study of the exposures on the New England islands, and feels that a considerable erosion period is indicated.[c] The truncation, as was first observed by Mr. Isaiah Bowman, is more nearly that which would be produced on a slowly subsiding coast by wave action than that caused by stream erosion at a high level. Of course, very long-continued erosion would eventually produce a base-level condition, but the decapitation of the folds on such limited areas as Gardiner, Block, and Nantucket islands, and Marthas Vineyard, under such favorable conditions as must have existed there, would be much more quickly and normally accomplished by wave action than by run-off.[d] It is therefore felt that the land during this erosion interval, instead of standing higher than to-day,[e] was 50 to 100 feet lower. As the name Gay Head belongs more properly to the folding[f] than to the erosion interval which followed, the name Gardiner interval is suggested for the latter, from Gardiners Island, where the truncated folds can be well observed.

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[a] Johnstrup, F., Über die Lagerungsverhältnisse und die Hebungsphänomene in die Kreidefelsen auf Möen und Rügen: Zeitschrift Deutschen Geol. Gesell., Band 26, 1874, pp. 533–585. Reid, Clement, The glacial deposits of Cromer: Geol. Mag., new series, vol. 7, 1880, pp. 55–66, 238–239; The geology of the country around Cromer: Memoirs Geol. Survey England and Wales, 1882. Geikie, James, The Great Ice Age, 1894, pp. 339–341, 426–430.

[b] Lyell, Charles, On the bowlder formation or drift and the associated fresh-water deposits composing the mud cliffs of eastern Norfolk, London, and Edinburg: Phil. Mag., vol. 16, 3d ser., 1840, p. 379.

[c] Bull. Geol. Soc. Am., vol. 8, 1897, pp. 207–211.

[d] See references to destruction of European coast by wave action in Lyell, Principles of geology, vol. 1, 1872, pp. 507–564; Geikie, Text-book of geology, vol. 1, 1903, pp. 571–593; also Chamberlain and Salisbury, Geology, 1904, pp. 326–331; Shaler, Sea and land, pp. 1–30; Tarr, Physical geography, pp. 332–333.

[e] Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1896, table facing p. 988.

[f] See usage of "Gay Head diastrophe," by Woodworth, Bull. Geol. Soc. Am., vol. 8, 1897, pp. 207–210. Professor Woodworth writes, December 5, 1904: "In regard to the use of the phrase "Gay Head folding" or its synonym, "Gay Head diastrophe" I agree with you that it is desirable to restrict it to the mere fact of the episode of the dislocation and to free it from the idea of erosion which followed the time of folding. It was an oversight on my part in not specifically abandoning the earlier term of the "Gay Head interval," which covered the whole question of the unconformity."

A

B

HORIZONTALLY STRATIFIED TISBURY (MANHASSET) SAND AND GRAVEL BEDS, WITH INCLUDED LAYER OF BOWLDER CLAY (DARK-COLORED BAND), MANHASSET BOWLDER BED, KING'S SANDPIT, HEMPSTEAD HARBOR, N. Y.

TISBURY (MANHASSET) GRAVEL.

CONDITIONS OF DEPOSITION.

The subsidence that began near the close of the post-Mannetto erosion interval, and gradually increased during the Jameco, the Sankaty, the Gay Head, and the Gardiner culminated in the Tisbury epoch, with a total depression of 200 to 250 feet below the present sea level. The ice again advancing passed beyond the continental border and deposited great beds of outwash gravel in the border of the sea and around the higher parts of Long Island, then a group of rather small islands. As these deposits were perhaps laid down to a great extent by a retreating ice sheet, it is possible that the ice extended south of the Sound and that the gravel capping the Half Hollow Hills south of the Wisconsin deposits, and lapping around the southern edge of the West Hills was deposited in this earlier greater advance. The greater portion, however, was formed when the ice was but a short distance north of the present shore, the northern edge of these deposits terminating along this line in the rather abrupt scarp of a sand plain. The deposition took place very near sea level, and at times the submergence was sufficient to allow floating ice. Such conditions are thought to have controlled the formation of the bowlder bed in the midst of the stratified gravels in the region about Hempstead Harbor and caused the irregular distribution of bowlders through beds of the same age on Marthas Vineyard. (See Pl. VIII.)

CHARACTER OF DEPOSITS.

The deposits of this epoch consist of quartz sand and gravel, containing a relatively small proportion of slightly weathered compound crystalline pebbles. They lie horizontally on the truncated folds produced by the Gay Head folding and Gardiner erosion and are separated from the Wisconsin deposits by a marked unconformity. On Long Island they differ from the Jameco in the small amount of erratic material which they contain and from the still older Mannetto in the very slight weathering of the compound pebbles. These lithological distinctions can not, however, be regarded as absolute, and confirmatory stratigraphic evidence must be sought in all cases.

PRESENT DISTRIBUTION.

Woodworth has shown that on the north shore of Long Island the Tisbury sands were deposited as a comparatively level, plateau-like plain, reaching a height of over 200 feet. In this region the beds are most characteristically developed and attain a maximum thickness of 150 to 250 feet. Deposits are commonly thinner near the axes of the peninsulas and thicken toward the valleys, as would be expected from their deposition over an antecedent topography.

The surface exposures show that the Wisconsin is relatively thin, and while there is always a chance of correlating some Mannetto or Cretaceous with this gravel, or of including stratified sand and gravel of Wisconsin age, the following table may be regarded as giving a fair approximation of the thickness of these beds in this region.

TABLE III.—*Thickness of late Pleistocene deposits in wells on the north shore of Long Island.*

No [a]	Location.	Total depth.	Recent to Wisconsin.	Tisbury.
151	Corona	190	?	90±
239	Whitestone	95	25±	?
241	.....do	120	15	45
246	Elm Point	104	12	44+
247	.....do	67	30	36?
326	Thomaston	79	27	14
457	Glen Cove	186	9+	149
459	.....do	170	41	109
460	.....do	108	?	90±
465	Dosoris	215	6+	100±
476	Lattingtown	265	7	100
477	.....do	110	?	100±
484	.....do	108	0	108±
485	.....do	110	0	100±
564	Mill Neck	330	?	100±
596	Cold Spring Harbor	228	0	190
601	.....do	195	0	195±
613	.....do	176	14	86
624	Huntington	181	80	75±
628	.....do	498	10	78
629	.....do	97	25	60
633	Lloyd Point	250	(0−	95)
651	Huntington	102	?	102
652	.....do	75	10	70
654	Centerport	185	.....	175
659	Greenlawn	186	0	[b] 186
660	Northport	196	0	196
666	Little Neck	143	.....	130
667	.....do	127	.....	127+
683	Kings Park	152	4	152
686	Fort Salonga	120	?	115
687	.....do	106	?	106±
720	Smithtown	212	0	130
724	Stony Brook	110	0	110
750	St. James	150	60?	90
751	.....do	250	30	[c] 220?
763	Setauket	320	0	85
811	Port Jefferson	370	11?	270+
825	Wardenclyffe	347	?	135±
892	Greenport	690	20	80

[a] These numbers correspond with those used in Chapter IV, where additional details will be found.
[b] Outwash and Tisbury.
[c] Glacial, may be in part older than Tisbury.

On the south shore the thick beds of sand with only a slight percentage of glacial material, which occur between the Sankaty clay and the surface Wisconsin gravel, are regarded as largely Tisbury.

VINEYARD INTERVAL.[a]

CHARACTER OF SURFACE AT BEGINNING OF INTERVAL.

On Long Island the Tisbury deposits to a large extent buried the older topography. They continued the filling of the Sound Valley across western Long Island, which was begun in the Jameco epoch, and buried the deep valleys which had been developed in the northern portion of Long Island by streams flowing into the Sound River. It does not seem probable that the deposits extended entirely across the Sound, as they would have done had they been normal marine deposits.

MAJOR DRAINAGE.

With the retreat of the ice and the elevation of the land the rivers from the mainland discharged into the depression overlooked by the sharp edge of the great Tisbury sand plain. The old channel across western Long Island having been completely filled by these deposits, the Housatonic must have discharged either through East River or to the east. The latter direction is indicated by the soundings in Long Island Sound.[b] Dana has suggested that those soundings indicate that the river crossed the North Fluke near Mattituck. If such was its course, it probably continued southward, as indicated in Pl. VI, *D*. There is, however, no reason for regarding this course as any more probable than a continuation eastward to a juncture with the Connecticut.

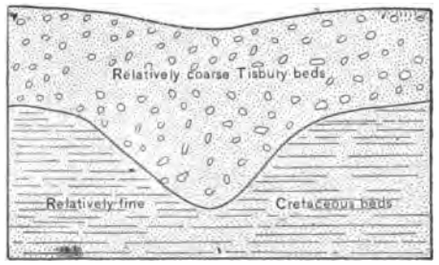


FIG. 19.—Diagram illustrating factors giving spring phenomena great power in reexcavating the north shore valleys.

The normal course for the Connecticut under these conditions would be between Plum and Fishers islands and Montauk Point and Block Island, and the present deep channel between these points is believed to be ultimately traceable to this cause. Moreover, the soundings of the Coast Survey show, at a depth which other considerations caused to be selected for the supposed shore line during this epoch, a distinct deltaform projection at the point where the Connecticut must have discharged (Pl. VI, *D*).

REEXCAVATION OF THE NORTH SHORE VALLEYS.

With the establishment of these new drainage lines the reexcavation of the valleys on the north shore began along lines determined by the position of the buried valleys of the northward-flowing streams of the pre-Tisbury epoch. This reexcavation was greatly aided by the great porosity of the materials filling the valleys, which concentrated the underground waters in the older depressions and gave

[a] Woodworth, Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1896, p. 979.
[b] Dana, Am. Jour. Sci., 3d series, vol. 40, 1890, pp. 426–431.

rise to large springs [a] (fig. 19). According to this idea the deep reentrant valleys on the north shore represent only partly resurrected pre-Jameco valleys, whose upper portions are still partially buried and whose present heads represent the limit to which the Tisbury sand and gravel has been removed, with perhaps some minor modifications produced by the Wisconsin ice.

LENGTH OF INTERVAL.

The amount of erosion represented is many times greater than that accomplished in post-Wisconsin time, though considerably less than that inferred to have been accomplished in the post-Mannetto or post-Lafayette.

WISCONSIN EPOCH.

CONDITIONS OF DEPOSITION.

At the close of the long Vineyard erosion interval the ice again advanced, passed over the irregular remnants of the Tisbury beds, rounded out, but did not

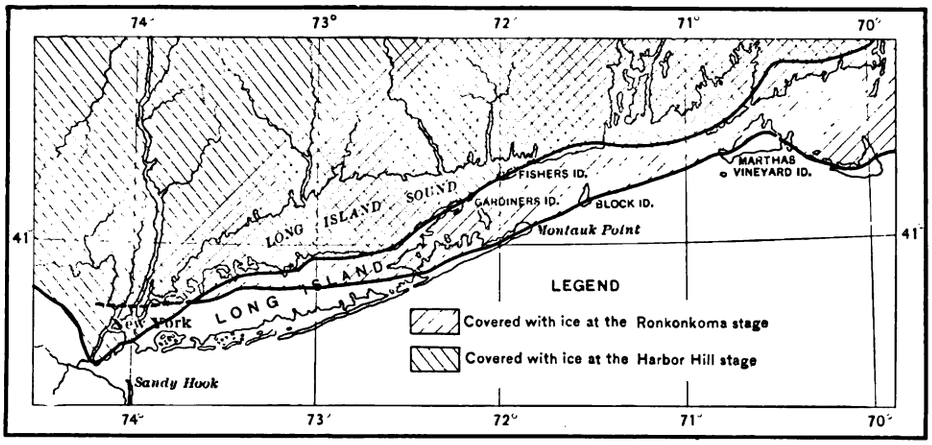


FIG. 20.—Sketch map showing relative positions of the ice during the Ronkonkoma and Harbor Hill stages of the Wisconsin period.

greatly modify, the valleys redeveloped in the Vineyard interval, and extended southward to the remnants of the Perrineville Wold, page 31 (Pls. V and IX, *A*). As the Wisconsin deposits have not been greatly modified by erosion nor buried under nor commingled with younger deposits, the records of this ice advance are much more complete than those of the preceding periods. It is known that the ice advanced to a line roughly extending from Long Island City to Montauk Point, Block Island, Marthas Vineyard, and Nantucket (Ronkonkoma moraine, fig. 20); that it then retreated and, the relative source of supply changing, advanced along a different line, passing the first advance in western Long Island, but not reaching it from Lake Success eastward (Harbor Hill moraine).[b] The ice then retreated and the records of its minor halts have been found by Woodworth near Port Washington and College Point.

[a] On the effect of springs, see Mather, W. W., Geology of the first district, 1843, p. 33; Stone, Mon. U. S. Geol. Survey, vol. 34, 1899, p. 19.

[b] Woodworth, Bull. N. Y. State Mus., No. 48, 1901, pp. 641, 642.

A. PORTION OF THE HARBOR HILL OUTWASH PLAIN OVER THE TISBURY TERRACE, SOUTH OF HUNTINGTON, N. Y.

The West and Half Hollow hills in the distance mark the southern limit of the ice and represent a portion of the Perrineville Wold with a slight morainal covering.

B. BOWLDERY PORTION OF THE HARBOR HILL MORAINE NEAR CREEDMOOR, N. Y.

U.S. GEOL. SURV.

CHARACTER OF DEPOSITS.

The Wisconsin deposits on Long Island do not differ in any respect from those on the adjoining mainland, which have been fully described by Salisbury in his report on the glacial geology of New Jersey.[a] They show the same major divisions of till (unstratified drift or bowlder clay) and stratified drift, forming terminal moraines, till plains or ground moraines, outwash plains, kettle plains, deltas, etc. Terminal moraines (Pl. IX, *B*) represent more or less hilly accumulations formed at the end of an ice sheet during a halt; they are for the most part composed of till or unstratified material, but may under some circumstances show considerable stratification, when they become known as kames. Deposits which are formed under the ice, or when the ice is moving at such a uniform rate that it does not form a hilly accumulation in well-defined belts, are called till plains or ground moraines. When the ice is melting rapidly the outflowing water carries off a great amount of detrital material, which is spread out as alluvial fans, and when many streams are concerned in this action the adjoining fans coalesce and give rise to a comparatively level plain, called a sand or outwash plain, at the edge of which the more important fans produce a distinct lobate effect. If detached masses of ice are buried in this outwash plain, when the ice retreats these masses melt and produce a pitted or kettle plain. Deltas differ from sand plains in their more limited size and in the fact that they are formed in water by one major stream rather than by a great number of streams of about the same size.

The materials composing these several types on Long Island are largely derived from the local beds, for the most part from the Tisbury, and it is therefore not always possible to distinguish between the Tisbury and the reworked Tisbury belonging to the Wisconsin. The Wisconsin, however, as a rule contains a greater percentage of erratic material, shows decided morainic characteristics, and presents more or less pronounced topographic and stratigraphic distinctions.

Thickness.—The deposits of the Wisconsin, although widespread, are relatively thin. The till, which is regarded as its most characteristic deposit, has a thickness of 100 feet in places, and averages perhaps 10 to 20 feet. The extreme thinness of the Wisconsin can be well observed along the north shore, where the waves expose bluff sections. In the outwash plains the distinction is not so sharp, and considerable difficulty is experienced in drawing a line between the Tisbury and the Wisconsin outwash. If the more erratic portion of the plain is regarded as Wisconsin, the thickness of the deposits increases from only a few feet near Babylon to 192 feet at Ridgewood (fig. 10).

In the following table the more noteworthy occurrences have been brought together. Additional data will be found in the table, page 118, and in the detailed well records, page 168.

[a] Final Rept. State Geol. New Jersey, vol. 5, 1902.

17116—No. 44—06——4

TABLE IV.—*Thickness of Wisconsin deposits on Long Island.*

No.[a]	Location.	Pleistocene (Recent to Mannetto).	Wisconsin.		Tisbury.	Remarks.
			Till.	Stratified gravel.		
3	Brooklyn (sewer tunnel) Sixty-fourth and Sixty-second streets.	90+	80	10±	.....	
23	Brooklyn	135+	45	90±	.....	Stratified gravel may be in part Tisbury.
41	.....do	90+	60	30±	.....	Do.
42	.....do.....	84+	18	(?)	.....	
44	.....do.....	60+	60±	.....	.....	
46	.....do.....	60+	21	39±	.....	
35	.....do.....	275 ?	23	(?)	.....	Sand from 23–105.
32	.....do.....	105+	0	.....	.....	All sand.
141	Ridgewood.....	284+	(?)	192±	.....	
137	Spring Creek.....	149+	0	97±	29	
201	Jamaica.....	160+	0	30	55	
196	Springfield.....	180±	0	25	53	
162	Woodside.....	138 ?	38±	(?)	(?)	
326	Thomaston.....	42	27	(?)	15	
369	Manhasset Neck.....	(?)	26	.....	.....	
368	.....do.....	(?)	0	(?)	80±	
437	Roslyn.....	100	0	(?)	100±	
435	Wheatley Hills.....	40	40	(?)	(?)	
431	....do.....	80	80	0	(?)	
	....do.....	149	106±	0	15 ?	
	....do	90+	90	.....	.....	
751	St. James.....	250	30±	.....	.....	Very few wells report till in this region.
750	.....do.....	150+	60	(?)	90−	
760	Setauket.....	62	25	.....	.....	
765	Port Jefferson.....	50+	20	.....	30+	
764	.....do.....	40+	20	.....	20+	
818	Middle Island.....	39+	39	.....	.....	
894	East Marion.....	50+	38	.....	12+	
884	Shelter Island.....	53	12	.....	.....	
908	.....do	76	30	.....	46	

[a] Numbers correspond to those used on Pl. XXIV and in Chapter IV, where additional data will be found.

DEVELOPMENT OF TOPOGRAPHIC FEATURES.

The effect of the Wisconsin deposits on the topography of Long Island is almost everywhere visible. It is shown in the many local details, which in the aggregate are so pronounced that they cause one to lose sight of the fact that the major topographic features are older and that the Wisconsin deposits have caused but surface

changes in the topography of the island. Even had there been no Wisconsin ice and no terminal moraine Long Island would have existed and would have been roughly similar to the island of to-day. The island would have had a "backbone" and would have shown pronounced cliffs on the north shore, but many of the steep hills rising about 50 feet above the surrounding country would have been absent, as would the many lakes in funnel-shaped depressions and the immense bowlders which add so much to the picturesqueness of certain areas. These effects have been produced largely by transportation and deposition, though some features are traceable to erosion and folding.

Transportation and deposition.—The general effect of the Wisconsin epoch was to build up rather than to tear down. In some places it added materially to the relief, as in Brooklyn, which, without the moraine, would have been comparatively flat. In others, as in the West Hills, the older topography was so pronounced that it was not materially affected. The two lines of morainic hills, which have at times been regarded as the main skeleton of Long Island, are as a whole to be regarded as only surface deposits which are recognizable because of their peculiar minor topographic forms.

Associated with these morainic hills are kettle-shaped depressions, now the sites of many lakes, representing the positions of buried ice blocks which melted when the ice retreated. These depressions contain water when they satisfy either one of two conditions: (1) When they are lined with relatively impervious strata, which prevents the rapid outward passage of the water falling in them or draining from the adjacent hills, as Lake Success; and (2) when a portion of the depression lies below the main water table (pp. 61–63). In the latter case the level of the water represents the main ground-water table, and the character of the sides is therefore immaterial. Lake Ronkonkoma is an example of this class.

Erosion.—One of the most marked features of the southern plain are the dry stream channels slightly creasing it. These are now generally regarded as the work of glacial streams of late Wisconsin age. They are clearly not due to causes now in operation and contain streams only in their lower portions where the valleys cut the ground-water table.

Folding.—The wrinkling of the beds on Long Island by the Wisconsin ice was slight compared with the Gay Head folding, from which, as a rule, it may be readily separated. The most evident wrinkle, and the one which is of greatest topographic importance, is a low ridge which extends from Far Rockaway to Lynbrook. On the one hand the Sankaty clay underlying it shows that it is a true fold (fig. 13), and on the other the coarse Tisbury gravel at the surface shows that the folding is post-Tisbury, for had a fold existed in Tisbury time this coarse gravel would have been deposited in the hollow rather than on the crest. The axis of this fold is, moreover, exactly parallel to the Wisconsin moraine to the north, all of which indicates that it is due to the weight of the Wisconsin ice. The Sankaty clay, with its underlying water-logged gravel, furnished the favorable conditions necessary for the production of a phenomenon of this sort.

The accompanying depression of Jamaica Bay is but slightly connected with this folding. It represents for the most part a partly filled portion of the old Sound River depression.

POST-GLACIAL AND RECENT.

After the retreat of the Wisconsin ice the land stood somewhat above its present elevation. The only evidence indicating that this elevation was very considerable is that afforded by the close botanical affinities between the plants found in the sand hills of New Jersey, Long Island, and the New England islands. Hollick believes that the only explanation of this distribution is that since the Glacial epoch a land connection, broken only by the channels of the Hudson and Connecticut rivers, existed for a sufficient period to allow the migration of these plants.[a] This would involve an elevation of from 100 to 200 feet, and so recent an elevation should have left very pronounced channels on the sea bottom. Thus far no channels have been found which can be referred definitely to this epoch, and it is this lack of corroborative evidence that is the strongest argument against so high an elevation. There is, moreover, the natural question whether a land connection is really necessary to account for this distribution of the "pine-barren flora."

Another line of evidence pointing to a higher elevation, though not to the total amount, is offered by the drowned forests along the south shore and by the less conclusive though corroborative phenomena of barrier bars and receding sea cliffs. While buried vegetable deposits, barrier bars, and receding sea cliffs may, and often do, occur under conditions which do not indicate subsidence, the evidence at this point will bear no other interpretation.[b] The tree stumps are not driftwood, but are clearly in the places where they grew. The swamp deposits are being exposed on the beach as the barrier bars migrate inland. Indian shell heaps or "kitchen middens" are found which are now covered at very high tide. Most of these data are available in the bays and marshes along the south shore, where the conditions were particularly favorable for the preservation of records of this sort, but even here the subsidence recorded is scarcely greater than 30 feet.

The work of Cook in New Jersey has led him to estimate the rate of subsidence at that point at about 2 feet per century, and a somewhat similar rate must affect Long Island.

SUMMARY.

GEOLOGIC HISTORY.

Although Long Island is underlain by metamorphosed rocks which range from Archean to Silurian in age and which represent a long and complex history, its geologic history begins more properly with the Cretaceous deposits.

At this time the warping of the old land surface permitted a northward transgression of the sea, into which the rejuvenated streams carried the residual material formed in the preceding long period of erosion and weathering. In this region the basal Cretaceous beds are of the same age as the Raritan in New Jersey and belong to the upper Cretaceous; above these are more nearly normal sands and clays of Cretaceous age, the whole series having an aggregate thickness of 1,300

[a] Hollick, Arthur, Plant distribution as a factor in the interpretation of geologic phenomena, with special reference to Long Island and vicinity Trans. New York Acad. Sci., vol. 12, 1893, pp. 189–202.

[b] Lewis, E., Pop. Sci. Monthly, vol. 10, 1877, pp. 434–439.

to 1,400 feet. These beds are correlated with the New Jersey formations in part by paleontologic and in part by stratigraphic evidence. The great greensand marl beds which occur in the upper part of the Cretaceous in New Jersey are absent on Long Island, their place being taken by fine sands with local clay beds, indicating a considerable change in the local conditions of deposition. These beds form the substructure of the island and are responsible for its major topographic features, the Pleistocene beds only mantling the older deposits.

During the greater part of the Eocene this part of the coastal plain was above water, but late in the Miocene it was again submerged and received a covering of the same beds which are now found along the New Jersey coast. On Long Island these beds have been almost entirely removed by erosion and are now recognized only in the top of the West Hills section. This distribution is similar to that found in New Jersey, of which Long Island is but the normal geologic continuation; and unless there is a much greater discordance in structure between the Miocene and underlying beds than is now known, the Tertiary can not occur on the north shore of Long Island and will be found only as elevated outliers, with the possible exception of a portion of the South Fluke.

After the early Pliocene erosion interval the Appomattox or Lafayette formation was spread as a littoral deposit over the coastal plain. Deposits of this age have not been recognized on Long Island, unless they are represented by the Mannetto, which is regarded as younger—probably Pleistocene. In the succeeding very long erosion interval the land stood higher than before and was more deeply eroded. The events of the early Pleistocene were very similar to those of the late Tertiary; the Mannetto, though containing compound crystalline pebbles, which have caused it to be referred to the Pleistocene, is apparently a littoral deposit, similar to the Lafayette, and the succeeding long erosion period resembles to a great degree the late Pliocene (post-Lafayette) erosion interval. On Long Island the results would have been essentially the same, whether there was one submergence and one erosion or two submergences (Lafayette and Mannetto) and two erosion periods. All of the beds were profoundly eroded, and in the gradual subsidence following this uplift a continental glacier advanced well toward the north shore of Long Island, and the streams issuing from it deposited great beds of gravel (Jameco) in the old Sound River Valley across western Long Island and over eastern Long Island and the New England islands. As the ice retreated and the submergence continued beds of sands and clay (Sankaty) were deposited around the nuclei of older uplands. In this epoch the land stood about 50 feet higher than at present, and the climatic conditions, as indicated by marine fossils, were much the same as to-day. A very extensive and important deglaciation is, therefore, represented.

With the return of the ice in the period of the Gay Head folding some of these older beds were overridden and a wonderful series of superficial folds produced which involve alike the pre-Cretaceous beds, the Jameco gravel, and the Sankaty clay.

The tops of these folds in such exposed localities as Gardiners Island and the New England islands were then truncated by wave action, with the land about 100 feet below the present sea level. An estimate of the time involved in this

wave cutting gives it a length of perhaps 40,000 years more than that which has elapsed since the Wisconsin.

The progressive subsidence continued throughout the next glacial epoch, the Tisbury, when the land was about 200 feet below the present sea level. In this epoch great outwash gravel beds were deposited horizontally on the truncated folds of the older deposits and around the islands of the older land.

In the Vineyard interval, when the Tisbury glacier had retreated, the lands stood perhaps 200 feet higher than to-day, and the older valleys were partially reexcavated. The erosion of this epoch, although very great when compared with that which has occurred in post-Wisconsin time, is very small when compared with that of the post-Mannetto or the post-Lafayette.

After this period of erosion and high elevation the Wisconsin glacier approached Long Island, and after an initial advance, when the ice reached a line extending from Long Island through Montauk Point to Block Island, Marthas Vineyard, and Nantucket, the ice retreated and returned again with the relative position of the ice front somewhat altered. In this readvance it passed the limit reached by the first advance in western Long Island, but did not reach so far south to the east (fig. 20).

In the comparatively short time which has elapsed since the retreat of the Wisconsin ice the changes have been almost entirely those produced by wind and wave action along exposed shores. The relative position of the land and sea undoubtedly changed on the retreat of the ice, and while, according to certain peculiarities of the distribution of the flora, this change may have amounted to as much as 100 or 200 feet, there is no corroborative evidence of so high an elevation.

TOPOGRAPHIC HISTORY.

While the Atlantic coastal plain, of which Long Island forms a part, was subjected to some erosion during the Eocene, the elevation was either so slight that it left no pronounced record or the interval was so long that the country was essentially peneplained, and the beginnings of the present topography were not made until the post-Miocene uplift, when the streams emerging from the older land flowed directly across the coastal plain (Pl. VI, *A*). As the erosion progressed the thinner portions of the Miocene deposits near the Cretaceous contact were cut through, and the topography developed in this section began to show the effect of the differences in the hardness of the underlying strata. A low, longitudinal valley, or vale, was developed from the softer basal Cretaceous layers, and a belt of hill land, or wold, cut by the narrow transverse valleys of the coast-flowing streams, was formed from the overlying harder ones. To the south of Washington, where the cover of Miocene sediments was greater, the underlying Cretaceous was not reached, and the topography showed no distinctive features. In the Lafayette submergence, which followed, a littoral deposit was spread over the coastal plain, mantling the low topography developed in the post-Miocene. The narrow transverse valleys were obliterated more completely than the broad vale, and when the land was again elevated the rivers discharged into a longitudinal trough. Had there been no deflection the streams must have cut new

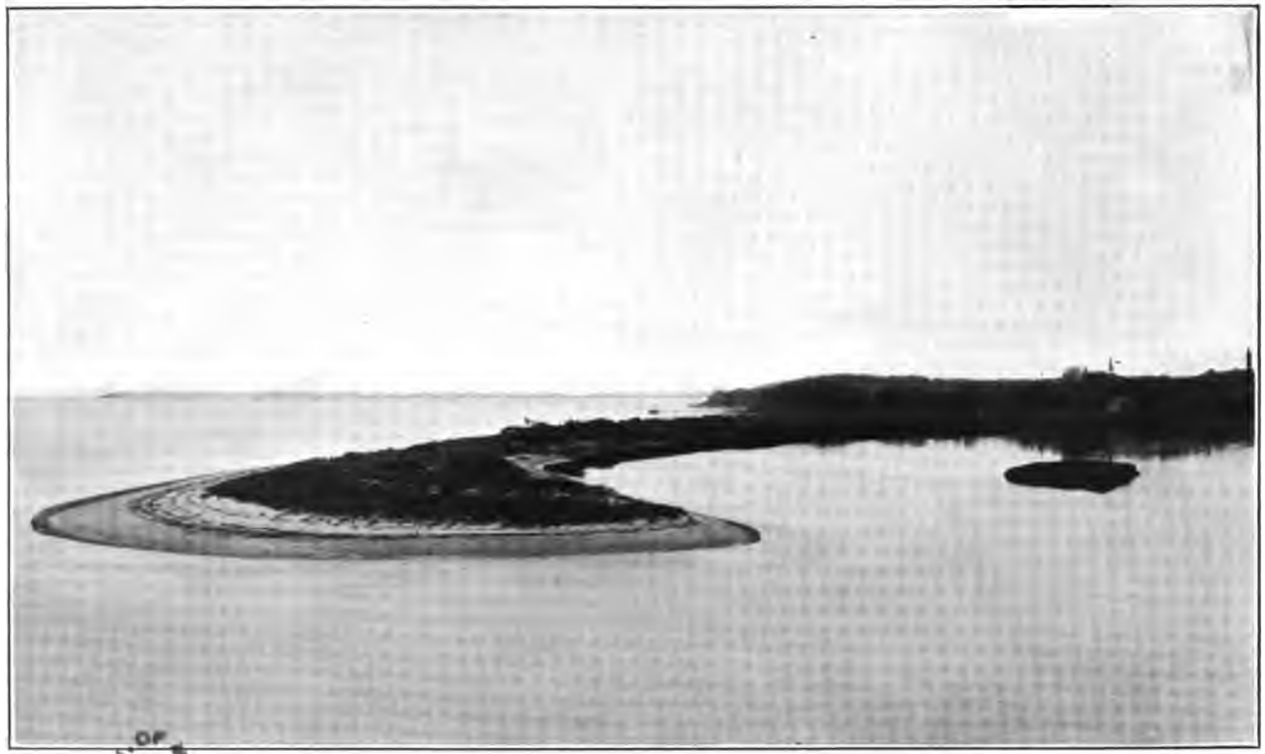
channels through the barriers afforded by this ancestral Perrineville Wold (see p. 31) and by the more or less filled channels through it, but as there was a tilting to the south the rivers flowed down the partly filled Hightstown Vale until they found a partly filled break of a lower stream through which they could turn seaward. As the land rose higher and higher these streams trenched deeper and deeper, and at the end of the long late Pliocene (post-Lafayette) erosion interval the present topographic features of the coastal plain were well developed (Pl. VI, *B*). The Hightstown Vale was strongly marked, being more pronounced on the north than on the south, owing to the greater thickness of the Miocene deposits in the southern region. In it were found the northeast-southwest portions of the Potomac, Susquehanna, Delaware, and Sound rivers. Seaward of this vale was the range of hills now recognized as the Perrineville Wold, considerably dissected, but essentially continuous from southern New England to Virginia. The breaks in this range were of two kinds—those due to the present channels of the rivers where they turned seaward from the Hightstown Vale, and those possibly representing coastward channels of these streams in pre-Lafayette times before their deflection, which have persisted because of this slight initial advantage. Of such an ultimate origin may be the depression in the Perrineville Wold across New Jersey along Rancocas and Mullica rivers, and in Delaware and Maryland between Delaware and Susquehanna rivers.

As the subsidence which followed the late Pliocene (post-Lafayette) uplift progressed the Hightstown Vale became a coastal sound and the Perrineville Wold developed into a chain of islands. One of these was the first Long Island, and while it was somewhat different in shape from the present island, it showed many points of similarity. It was from this nucleus that the present island was developed.

In the Jameco, Sankaty, Gardiner, and Tisbury epochs the portion of the Sound Valley crossing western Long Island was largely filled, some of the beds were profoundly folded, the position of some of the more prominent points of the archipelago to the eastward changed, and a great deposit of gravel was laid down about the older nuclei. When the land was again elevated, Long Island showed more nearly its present outline. The Tisbury had filled in and rounded out the older topography and made a body of land somewhat larger than that of to-day, with a northward-facing scarp not far from the present bluff line. The short, deep valleys running northward from the crest of the wold were buried, and there were, therefore, no deep, reentrant bays or valleys such as now characterize this shore. The Connecticut, no longer able to discharge westward, cut a new channel directly seaward between Fishers and Plum islands on the one side and Block Island and Montauk Point on the other. The Housatonic probably flowed eastward and joined the Connecticut near Fishers Island.

As the elevation continued the excavation of valleys in the Tisbury began along lines determined by the preexisting valleys, in which, because of the difference in the porosity of the Tisbury gravel and the Cretaceous sands, the underground waters were concentrated. It is to this excavation, in which springs played a large part, that the present shape of the north shore valleys is in a large measure due.

After this period of elevation the ice again advanced, and, by means of its relatively thin superficial deposits gave to Long Island its present glacial topography. The moraines were deposited without regard to previous topography, and therefore filled the Sound River Valley in Brooklyn, and to the east covered the older hills, giving rise to the erroneous correlation of the whole hill mass as moraine. In the outwash deposits accompanying these moraines, as well as in the moraines themselves, masses of ice were buried which, on the final retreat of the glacier, melted, and produced the many picturesque kettle holes which now dot the island. The channels across the southern plain were also produced at this time, and the shape of the north shore valleys was probably slightly modified. The changes since the retreat of the ice have been relatively slight and largely restricted to the shores; the waves have worn back the headlands, and the winds and tidal currents have carried this débris along the shore to form bars and spits, sometimes long, with but one end fixed, as the great barrier bar which extends from Montauk Point to Fire Island, sometimes fixed at both ends, as the bars which connect the former islands of Lloyd Neck, Eaton Neck, and Center Island, with the mainland. Behind these bars marshes have formed which, with the silt brought down by the streams, have been struggling to reclaim such areas from the sea. Along the beaches and in the areas laid bare of vegetation by man, or forest fires, the winds have taken up the loose sands and piled them into dunes.



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HOOKED SAND SPIT AT ENTRANCE TO SMITHTOWN HARBOR, LONG ISLAND.

An illustration of a recent change in the shore line. Photograph by Edward P. Buffet.

CHAPTER II.

UNDERGROUND WATER CONDITIONS OF LONG ISLAND.

By A. C. VEATCH.

GENERAL PRINCIPLES.

SOURCE OF UNDERGROUND WATER.

The water that falls on the land in part flows off on the surface and in part sinks into the ground. In both cases a portion is returned to the atmosphere by evaporation, and another portion is consumed by living organisms and in chemical work. The water which flows on the surface is called the run-off, though this term is used to include also the water which returns to the surface after a greater or less underground passage. The water which sinks into the ground through the interstices of the soil or rock, and furnishes the supply for springs and wells and in some cases for ponds and lakes, is called the ground water.

TRANSMISSION.

The "channels" through which this underground water moves are, with rare exceptions, the small spaces between the particles of which the rock is composed, as the sand of a sand bed or sandstone, or the gravel of a gravel bed or conglomerate; therefore, the coarser or more porous the bed the greater its water-carrying power. Water that travels through breaks in the rocks such as joint planes or fractures is rarely of very considerable economic importance and never, except in the case of limestones in which caverns have been developed, forms an underground stream in the usual sense. In the study of underground water it is therefore necessary at the outset to abandon the idea of underground streams resembling surface streams, and to conceive of the water as passing through the very small interstices of sand or gravel or other porous bed, rather than in great open channels or conduits.

The motion of underground water, like that of surface water, depends entirely on gravitation, and the rate of motion—or rapidity of flow—depends on two principal factors—slope and resistance. Surface waters are entirely unrestricted in one direction and their channels therefore readily adjust themselves to any amount of water, the only resistance being that of the bed and banks; underground waters, on the other hand, are carried in a "channel" composed of an infinite number of small openings, each of which offers a resistance that varies inversely as its size, the

advances—the Tisbury and Wisconsin. These are, for the most part, sand and gravels, though here and there are local beds of clayey material which, while they give rise to local water tables that may be of value for local wells, ponds, or springs, are of no general importance.

The more important results of these geologic conditions are:

1. The rain water sinks directly into the very porous surface gravels and produces, therefore, practically no run-off, except that supplied by springs. Since all streams are spring fed there is great difficulty in determining the exact limits of the watersheds, which depend on the relief of the ground-water table and only indirectly on the shape of the surface.

2. As the greater portion of the water of the island is under ground, and as the 25 to 30 per cent which normally returns to the surface is exposed for but a relatively short distance, the percentage of the total rainfall lost by evaporation

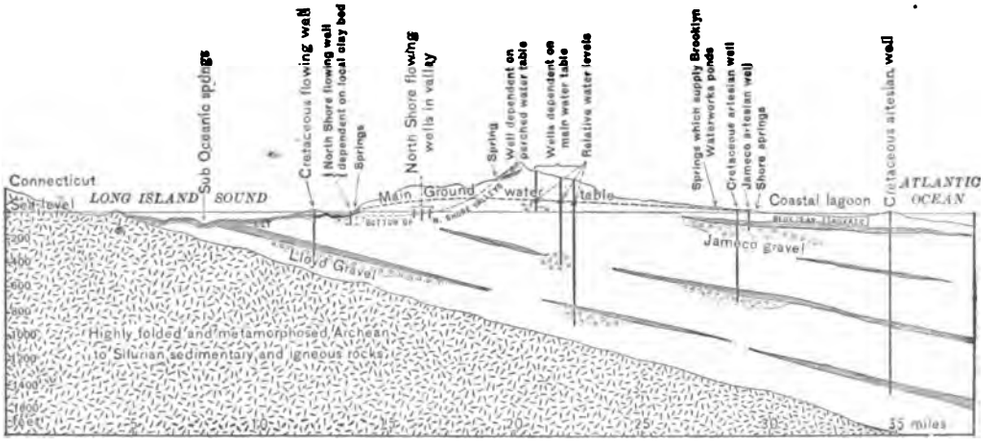


FIG. 24.—Diagrammatic cross section of Long Island, showing general water conditions and cause of flowing wells.

is abnormally small and the yield of this watershed, could all the water be economically obtained, would, therefore, be larger per square mile than in any adjoining areas.

3. As there is no uniform "blue-clay floor," or other extensive geologic barrier, a portion of the ground water passes coastward in the upper gravels and another portion, and by no means a negligible one, sinks into the Jameco and Cretaceous sands and finally escapes in the form of suboceanic springs. This transmission of water is one of the more important factors of the underground conditions of Long Island. There is no geologic reason why a relatively important portion of the rainfall should not pass seaward in the beds below the surface gravel, and that this occurs has been proved by the many deep wells on the island and by the work of Prof. Charles S. Slichter, who has shown that there is a greater velocity beneath the bed of blue clay than in the surface gravel, page 102.

GROUND-WATER TABLES.

As all the water on the island is of ultimate ground-water origin, one of the most important points to be determined is the exact position of the ground-water table, since on it depends the stream flow, the depth to permanent water in wells, and the pressure in artesian, or flowing, wells. Were the island entirely homogeneous in composition there would be but one water table, which would be at ocean level on either side and would gradually rise toward the highlands in a curve entirely symmetrical with the surface, and at a depth determined by the porosity of the soil and the amount of rainfall. No wells, or springs, or ponds would be possible, except where this ground-water table was reached, and no water in any well would

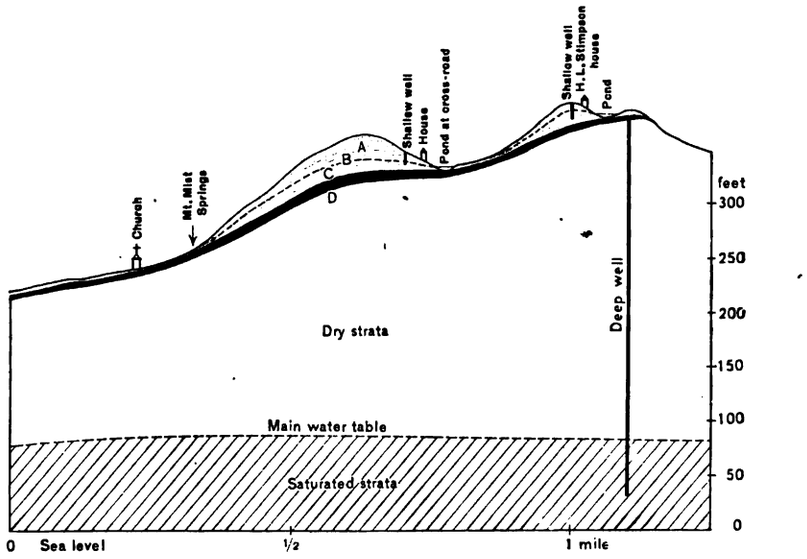


FIG. 25.—Diagram showing perched water table on north side of West Hills and source of Mountain Mist Springs. A, unsaturated strata; B, perched water table; C, saturated strata; D, relatively impervious till.

rise above the ground water at that point. There would, therefore, be no artesian wells.

As the island is not entirely homogeneous, the upper limit of the zone of complete saturation—that is, the main ground-water table, or "main spring," as it is locally called—is not entirely symmetrical with the curve of the surface, and there are, moreover, a number of more or less limited areas of saturated beds above the main one.

PERCHED GROUND-WATER TABLES.

These perched ground-water tables are for the most part confined to the moraine where local clay or other relatively impervious layers have arrested the flow of the underground water and prevented it from reaching the main ground-water table. One of the best examples of such a perched water table is found in the northern end of the West Hills, where a relatively impervious bed is furnished by the Wisconsin till (fig. 25). Other examples are shown in fig. 24 and Pl. XI.

MAIN GROUND-WATER TABLE.

The general character and position of the main ground-water table is shown in Pls. XI and XII, which are based on the careful work during the summer of 1903 of the Long Island division of the New York commission on additional water supply. This work has developed the interesting point that while the slope of the ground-water table is in a general way the same as that of the surface, the divide of the ground water is farther to the north than the surface divide.

SPRINGS.

Whenever the main water table, or one of the perched water tables, is intercepted by the surface a spring is formed.

SPRINGS DEPENDENT UPON PERCHED WATER TABLES.

The water of springs dependent upon perched water tables penetrates the earth until it reaches a relatively impermeable stratum above which it collects, and along which it passes until it finds an outlet. Springs of this type are common wherever a perched water table occurs, and represent essentially the overflow of these underground basins. The much talked of springs that occur at the summits of hills or mountains are invariably of this class, and examination always shows that, though relatively at the top of the hill, there is always an appreciable area of higher ground above them which serves as a reservoir. The Mountain Mist Springs in the West Hills are of this type, and while they are situated at a height of about 280 feet above sea level, the hill behind them rises 140 feet higher, and there are several hundred acres of land to serve as a catchment area and reservoir (fig. 25). Springs of this type are found in many places along the north shore, and are particularly abundant where the fine Cretaceous beds are overlain by coarser Pleistocene gravels.

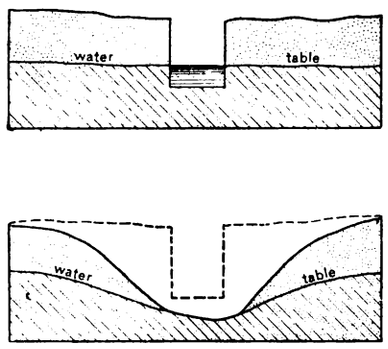
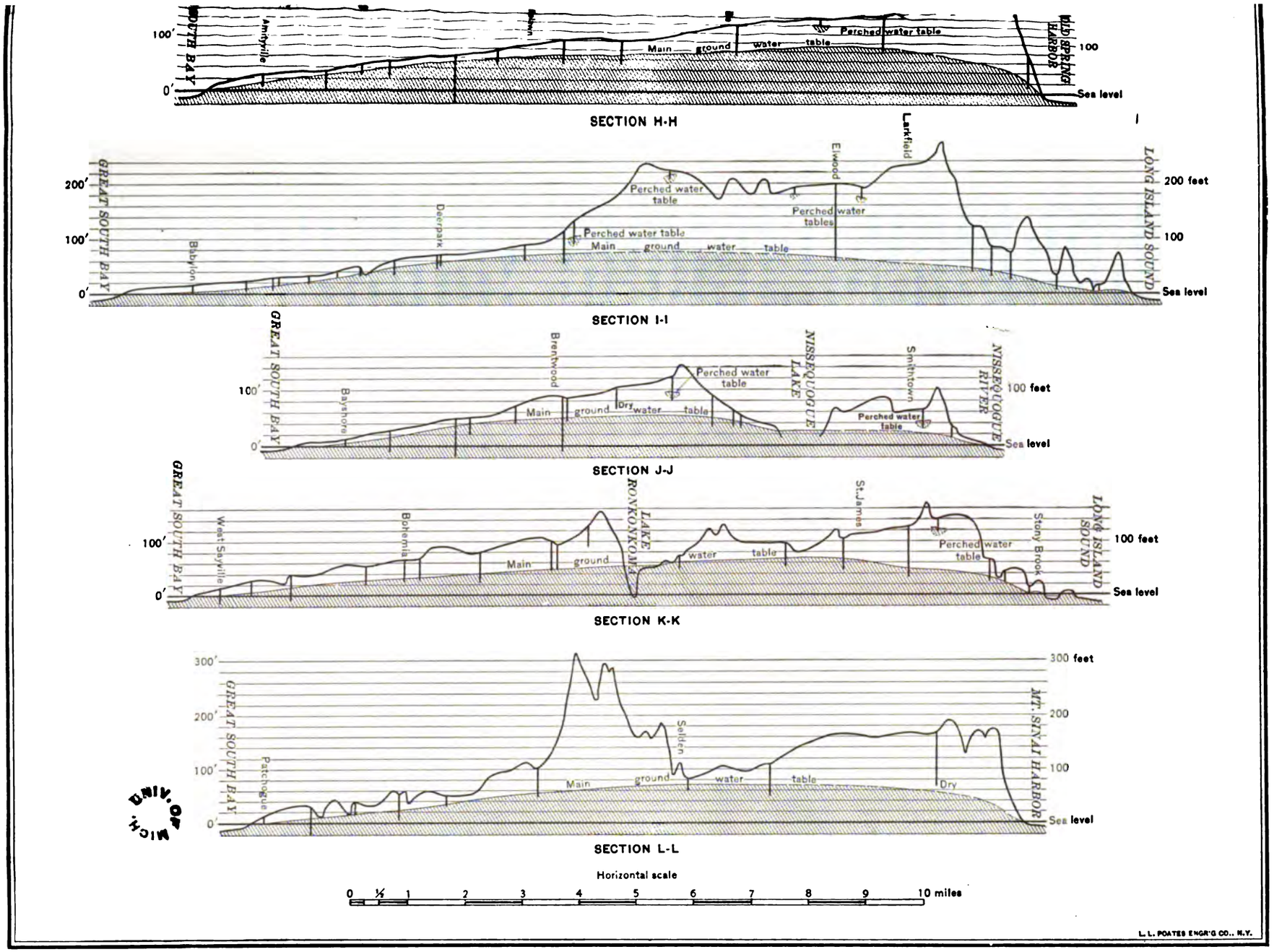


FIG. 26.—Diagram showing analogy between a well and a channel that cuts the ground-water table.

SPRINGS DEPENDENT UPON THE MAIN GROUND-WATER TABLE.

The water of springs formed by the cutting of the main water table escapes from the top of the water-logged beds, rather than at their base, as in the springs just discussed. The channels which cut this water table may be regarded as large wells, with one side open, into which the water is flowing and escaping (fig. 26). The old glacial channels across the southern plain invariably cut the ground-water table near their lower ends, and at the point where this occurs little streams start which grow very rapidly as the channel gets deeper into the saturated layers. A quantitative determination of this increase in Hempstead Brook was made by the engineers of the Brooklyn waterworks in 1895. This valley, which was perfectly dry just above Hempstead village, showed an average dis-

SECTION D-D
100 feet
Sea level
HEMPSTEAD HARBOR
Mineola
Main ground water table
Millburn reservoir
Pond
Baldwin
MIDDLE BAY
100
0
SECTION E-E
300 feet
200
100
Sea level
LONG ISLAND SOUND
Gates
Guthrie
Baldwin
Friends school
Dry
Perched water tables
Greenvale
Perched water table
Morgan well
Perched water tables
Main ground water table
Duryea
Westbury
Merrick
EAST BAY
300
200
100
0
SECTION F-F
200 ft.
100
Sea level
LONG ISLAND SOUND
Center I.
OYSTER BAY HARBOR
Oyster Bay
East Norwich
Perched water tables
Locust Grove
Main ground water table
Hicksville
Massapequa
SOUTH OYSTER BAY
200
100
0
SECTION G-G
200 feet



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CROSS SECTIONS OF LONG ISLAND, ALONG LINES GIVEN IN PLATE XII.

Showing position of the main ground-water table and of several perched water tables on July 1, 1903. Shaded areas are water-logged. Compiled from sections by Walter E. Spear, division engineer, New York City commission on additional water supply.

charge of 229,278 gallons per day at the Jackson street crossing and 675,907 gallons a mile lower down, near Mill road and Grove street, while at the efflux chamber at the end of the reservoir the discharge was 5,618,603 gallons—an increase of five and a half million gallons[a] in about 3 miles (fig. 27); and, as explained on page 62, had there been no dam at this point the flow would have been much greater.

On the north shore the reentrant bays cut deep into the main water table, and large springs are abundant at, and near, high-tide level. Surveys made in the early fifties by Daniel Marsh, under the direction of Gen. W. B. Burnett, showed a spring discharge available for water supply amounting to 23,617,824 gallons per day between Long Island City and Glen Cove.[b]

At the Fresh Pond pumping station (old Whitestone station) the spring flow amounts to 500,000 to 600,000 gallons per day, and the spring-fed pond at the Bayside (old Flushing) pumping station yields an average of 1,700,000 gallons. A small spring area on the east side of Alley Creek, opposite the Bayside pumping station, and belonging to Mr. William Corry, was gaged in September, 1903, in connection with a study of the fluctuations of the wells of the Citizens Water Supply Company, and a yield of 365,000 gallons a day was indicated.

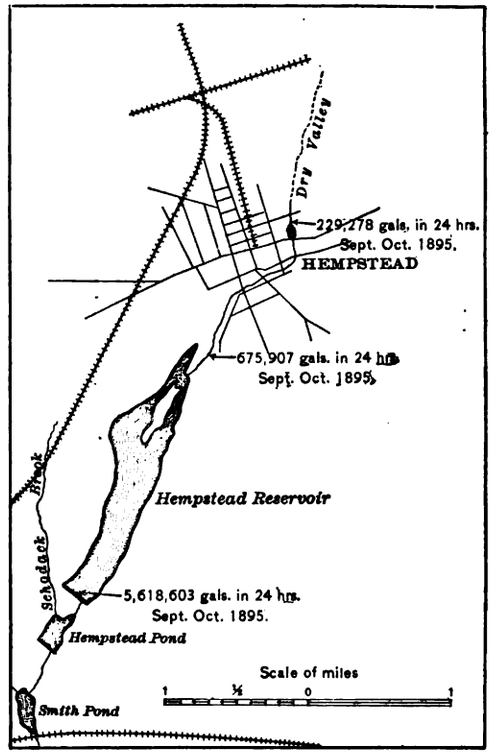


FIG. 27.—Sketch map showing increase in spring flow along Hempstead Brook. From data collected by the Brooklyn waterworks.

MINERAL SPRINGS.

The well-known solvent power of water, especially when containing carbonic acid, causes it to dissolve whatever soluble salts are contained in the beds through which it passes. Thus, all springs and well waters contain a greater or less amount of mineral matter in solution. Sometimes the ingredients have medicinal value, or the water is of so great relative purity that its use is recommended, and the springs are developed commercially. This forms "mineral water." So far as has been learned from a rather extensive inquiry, the waters of but four springs on Long Island have been put on the market, namely:

(643[c]) The Colonial Spring, one-half mile west of Wyandanch.
(643) The Mo-mo-ne Spring, one-half mile northwest of Wyandanch.
(593) The Mountain Mist Spring, 2 miles south of Huntington station.
(226) Deep Glen Spring, 1½ miles northeast of Richmond Hill.

[a] History and Description of the Water Supply of the City of Brooklyn, 1896, p. 58.
[b] Op. cit., p. 150.
[c] These numbers correspond with those used in Chapter IV, where additional data will be found.

STREAMS.

ORIGIN.

As has already been indicated, the streams on Long Island are fed almost entirely by ground water. The valleys in which they flow were not formed by the present streams, but under conditions which existed in the Wisconsin and Vineyard epochs (pp. 43, 44), and the present streams may, almost without exception, be said to be the result, rather than the cause, of the valleys which they occupy. In other words, had not the channels across the southern plain been cut during the Wisconsin epoch, there would now either be no streams, or the streams would be of small magnitude, and the water which is now collected in them would appear as springs along the shores. The drainage areas of such streams depend entirely upon underground conditions, and, as was early appreciated in the study of this region, they can not be outlined with certainty from surface conditions. Another point of importance in such streams is that the flow is unusually uniform; the great beds of sand and gravel act as equalizing reservoirs in which the intermittent rainfall is stored and distributed throughout the year.

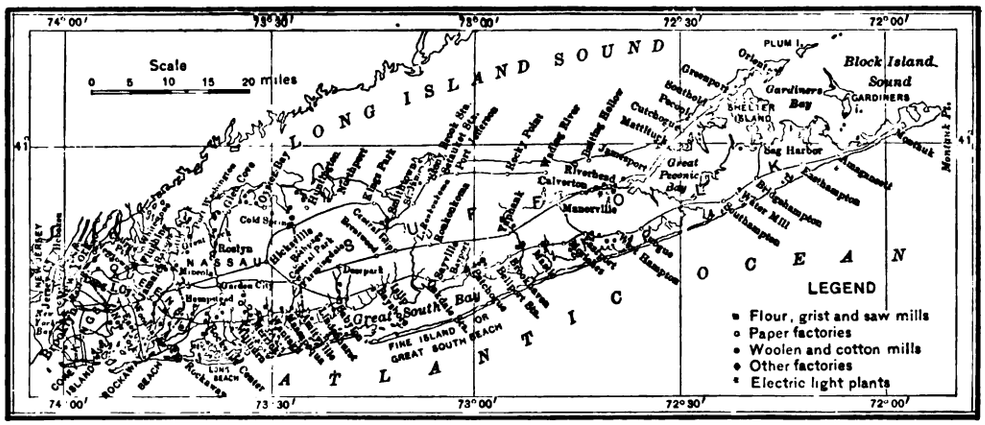


FIG. 28.—Sketch map of Long Island, showing distribution of water-power developments, 1800–1900.

WATER POWERS.

The comparatively steady flow of these short streams made them of considerable value for small water powers in the early history of the country, and one or more mills were erected along every important stream or branch (fig. 28). While a number of these were simply local grist or saw mills, requiring but a limited supply of water, a number of more pretentious mills were erected, among the more important of which the following may be mentioned:[a]

Jones & Co., Woolen Factory, Cold Spring Harbor.

Patchogue Electric Light Company (new plant built which uses steam).

[a] Damerum, Wm., Map of the southern part of the State of New York, including Long Island, the Sound, the State of Connecticut, part of the State of New Jersey, and islands adjacent, New York, 1815.

Burr, David H., An atlas of the State of New York, containing a map of the State and of the several counties; projected and drawn under the superintendence and direction of Simeon De Witt, pursuant to an act of the legislature; also the physical geography of the State and of the several counties and statistical tables of the same, pp. 7-29, New York, 1829, 120 pp., 52 maps.

Smith, J. Calvin, Map of Long Island, with the environs of New York and the southern part of Connecticut, New York, 1837.

Beers, F. W., Atlas of Long Island, New York, 1873, 192 pp., 97 maps.

Union Twine Mills, Patchogue.
Patchogue Manufacturing Company (water and steam), Patchogue.
Swan River Cotton Mills, East Patchogue.
Patchogue Paper Mill Company (water and steam), 1½ miles north of Patchogue.
Perkins Brothers Woolen Mills, 1 mile west of Riverhead.
Riverhead Electric Light Company (water and steam), 1 mile west of Riverhead.
Tower Roller Mills, Riverhead (includes pumping plant of Riverhead Waterworks).
C. Hallett's Sons' Flour Mills and Electric Light Plant, Riverhead.
Jagger & Luce's Flour Mill, Riverhead.
Phillips & Company, Factory, Smithtown.
Paper mills were also operated at Roslyn (3), Meadow Brook (3), Merrick, Babylon, Moriches, Patchogue, and Riverhead.

No new projects are heard of and many of the old ones are falling into decay, but there seems to be a good opening for small developments for local electric lighting and power, especially at such favorable locations as Roslyn and Cold Spring Harbor.

PONDS AND LAKES.

Like the springs, the ponds and lakes of Long Island are of two classes, one dependent upon perched water tables or relatively impervious strata, the other on the main ground-water table, quite independent of impervious layers.

PONDS AND LAKES DEPENDENT ON PERCHED WATER TABLES.

To the first class belong almost all of the lakes and ponds situated in the more elevated portions of the island. The natural ones are for the most part due to kettle holes made by the melting of blocks of ice detached from the glacier and buried during the last ice invasion, or to other irregularities of deposition by the glacier. When the sides of such depressions are of relatively impervious strata they collect the water falling in their limited drainage area, and form lakes or ponds. If the sides are composed of pervious beds, these depressions are dry, except where they extend below the main ground-water table. Ponds may be produced artificially by lining a depression or excavation with clay, and Mather states that at the time of his visit such artificial watering holes were a striking feature of the farming economy of the island.[a]

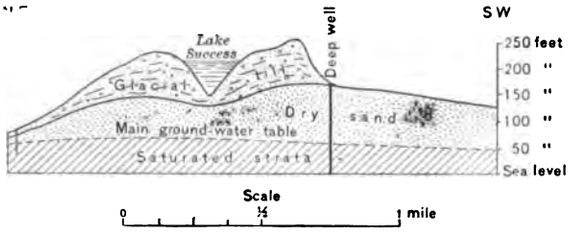


FIG. 29.—Lake Success; an example of a kettle-hole lake depending on local impervious strata.

The most striking example of a lake of this type is Lake Success, between Floral Park and Manhasset (fig. 29). It is situated high above the main water table and is clearly due to impervious beds in the moraine. Its watershed is very limited, and as a source of water supply would be of small value. Such a lake could be drained very easily, since if a hole were drilled in the bottom the water would escape

[a] Geology of the first district, 1843, p. 146.

into the dry sands below. Other notable examples of the same type are the ponds shown in fig. 25. Whether or not such a pond has a surface outlet is determined by the relative importance of the following factors: (1) Size and condition of catchment area; (2) amount of rainfall; (3) amount of evaporation; and (4) permeability of the sides.

PONDS DEPENDENT ON THE MAIN WATER TABLE.

As explained above, any depression, either natural or artificial, which cuts the main water table will tend to fill with water; if the depression is open at one end it will form a spring-fed stream; if closed, a lake or pond; or, if still more closely inclosed, simply a well.

FIG. 30.—Diagram showing effect of a pond on the ground-water table and consequent decrease in spring flow on southern Long Island. A-B, initial position of ground-water table: A-B′, resultant position of ground-water table. Arrows show direction of motion of ground-water.

If a dam is thrown across a depression which cuts the main water table the effect is to obstruct the flow and to impond the water. As the flow in such a depression depends on the spring discharge, which in turn depends on the steepness of the slope of the ground-water table near it (A–B, fig. 30), it is evident that a ponding of the water will decrease the steepness of the gradient and so reduce the spring flow. The crest flow of such a pond will, therefore, be much less than the normal flow of such a brook without a dam. Thus it has been found by the engineers of the Brooklyn waterworks that, under similar conditions, the Hempstead reservoir discharged 5,600,000 gallons per day when the water was maintained at a depth of 14.35 feet and 8,000,000 gallons when at 4 feet.[a]

If the water in a pond of this kind is raised above the level of the main water table in the adjacent divide (a condition which is possible because of the sloping nature of the ground-water table, the horizontal character of the surface of the pond, and the relatively rapid flow of the surface water) the ponded water will not only prevent a normal spring flow, but will flow out through the sides of the pond. (Fig. 31.) Such an outflow was clearly proved for the Hempstead reservoir by the engineers of the Brooklyn waterworks in 1878, when it was estimated that one million and a quarter gallons a day was transferred[b] by ground flow from Hempstead reservoir to Schodack Brook. (Fig. 27.)

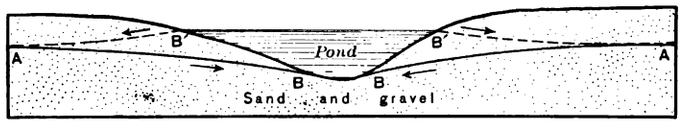


FIG. 31.—Diagram showing loss of water by leakage from pond whose surface is above the adjacent ground-water table.

The effect of dams in the brooks of Long Island is: (1) To raise the ground-water table; and (2) to very materially decrease the stream flow at the points where dams are erected.

In addition to the valleys which cut the main water table, and in which ponds are artificially constructed, a number of the large kettle holes extend below it,

[a] History and description of the water supply of the city of Brooklyn, p. 58, 1896. [b] Op. cit., p. 5.

and therefore contain water. In such cases it is not necessary that the depression be lined with impervious beds, the sides may be entirely of sand and the depression still contain water. To this class belong all the large important lakes east of the West Hills, among the more important of which are Lake Ronkonkoma, Artist Lake, Long Pond (near Wading River), Deer Pond, Swan Pond, Great Pond, Big Fresh Pond, Poxabogue Pond, and Long Pond (near Sag Harbor). Lake Ronkonkoma may be taken as typical. Fig. 32 shows the essential difference between it and lakes of the Success type.

This difference is very important if these lakes are ever considered as sources for municipal or village water supplies, for while the yield of Lake Success would be relatively small, the yield of Lake Ronkonkoma would be large. Lake Success could be very easily pumped dry, but to dry Lake Ronkonkoma it would be necessary to remove a large part of the ground water above sea level from perhaps one-third of Long Island. Its location near the center of the island, and its extreme depth, say 5 to 10 feet below sea level, make it an immense natural well of the utmost importance, and while the popular idea that Lake Ronkonkoma is supplied by an underground stream from Connecticut or New England is entirely unfounded, the relation of the lake to the ground water of the island and its effective drainage area when lowered, say 50 feet below its present level, would give it a yield quite comparable to that which the believers in such an underground stream imagine for it. (See Pl. XI and fig. 32.)

FIG. 32.—Lake Ronkonkoma: an example of a kettle-hole lake depending on the main ground-water table.

ARTESIAN AND DEEP WELLS.

The discussion thus far has been confined almost wholly to phenomena such as ground-water tables, springs, streams, lakes, and ponds, which relate to surface waters. It has, however, been pointed out that this water is relatively free to pass downward, and that when it passes beneath a retaining layer a head sufficient to produce a flow may be developed. The nature of this retaining cover is purely relative. It must always be finer than the water-bearing stratum, but although the ideal retainer is a very fine clay, under certain conditions a flow may be obtained from a fairly porous sand above a coarse gravel.

SHALLOW NORTH-SHORE ARTESIAN WELLS.

Cause.—Flowing wells in which there is only a sand covering are found near the heads of many of the deep reentrant valleys on the north shore. In these valleys the slope of the water table is very great and the velocity of the ground water considerable. Many springs break out near water level, and often a pipe sunk entirely through sand to a depth ranging from 30 to 150 feet will furnish flowing water (see fig. 33). In these cases it is doubtless true that the layer which furnishes the flowing water is coarser than the overlying ones and affords a freer passage for the water.

Such wells do not show many differences from the near-by springs. In the one a barrel is sunk 2 or 3 feet in the gravel and the water rises several inches above the surface. In the other a pipe 20 to 200 feet long is sunk entirely through sand and the water flows from it several feet above the surface.

Local clay beds are important in producing some of these flows, and in these cases the structure is essentially the same as that explained below for the Jameco gravels, which, in some of these north-shore wells, are doubtless the water-bearing horizon.

In most cases the water is from the Pleistocene gravels and the wells have yielded as high as 125 gallons per minute, natural flow. A flow of 50 gallons per minute is not uncommon (Pls. XIII, XIV).

Distribution.—While these wells are somewhat irregularly distributed, they are generally in the upper half of the steep-sided valleys or bays which characterize

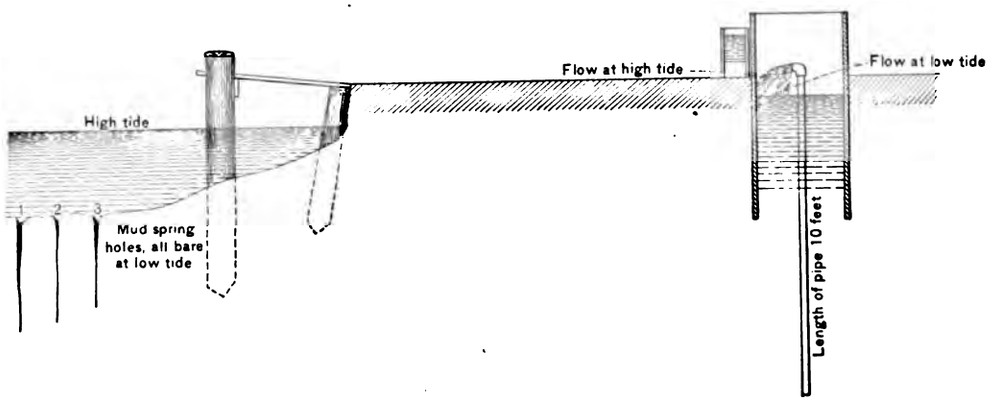


FIG. 33.—Artesian well or spring (No. 335) at Manhasset. From a drawing by J. H. L'Hommedieu.

the region (Pl. XV). They seldom occur more than 10 to 20 feet above sea level, although flows have been obtained at an elevation of 35 to 50 feet at Dosoris (466), Huntington (626), and Glen Cove (455).

Predictions.—Many shallow, 50- to 200-foot artesian wells will doubtless be developed along the north shore during the next few years, and in prospecting for them the heads of steep hollows or the bottoms of steep banks should be chosen in preference to other sites, and the lower the elevation the greater will be the chances for obtaining a flow.

THE JAMECO ARTESIAN WELLS.

Cause.—The water passing under the blue clay (Sankaty), into the Jameco gravels (fig. 24), has a head dependent upon the height of the water table above the landward edge of the clay, and as the sand and gravel is fairly coarse and the loss by resistance not great, when a well is drilled only a few feet above tide level, the water from this gravel has a sufficient pressure to flow. In this case, although the water-bearing stratum has no outcrop and is not inclined, porous beds connect it with the surface, and the slope of the water table supplies the lack of slope of the strata.

A. BURGESS WELL, OYSTER BAY.

Water rises to within 1 foot of top of pipe. Rod projecting above pipe is aluminum gage used in observations on tidal fluctuations.

B. JONES WELL, COLD SPRING HARBOR.

Water flows freely over elbow in pipe.

VIEWS SHOWING HEAD DEVELOPED IN THE NORTH SHORE ARTESIAN WELLS.

Distribution.—The head of water in the Jameco gravels rarely exceeds 10 feet and flows can, therefore, not be expected much above this height. This basin is best developed in the region of the old valley and becomes of lesser importance in passing eastward because of the conditions which governed the deposition of the Jameco gravel (see p. 34). The coloring of the Jameco artesian area on Pl. XV has therefore been discontinued near Babylon. At Riverhead the coarse gravels of this horizon again appear with a thin capping of clay, and yield as much as 130 gallons per minute, but the water is so chalybeate that it is necessary to obtain water from lower horizons. West of Jameco the artesian supply soon gives out because of leakage on the line where the Hudson has cut through the blue clay, and at the breaks in the clay layer at Barren Island and elsewhere.

Predictions.—The main outlines of this basin have been fully disclosed by the work of the Brooklyn waterworks. Along New York Bay no wells have reported potable water from this horizon and the limit of development must be drawn somewhere to the west of New Lots. On the south at Barren Island the blue clay is entirely absent, a fact which, it is believed, increases the danger of an influx of salt water from heavy pumping at the pumping stations to the north. This horizon may have an artesian value on the south side of the South Fluke, and near tide level wells 50 to 150 feet deep are likely to yield flows.

THE CRETACEOUS ARTESIAN WELLS.

Cause.—The water which sinks deep into the Cretaceous sands may pass under a clay sheet, and when this clay is penetrated at low points on the north and south shores, the head, which depends on the height of the water table above the landward edge of the particular clay layer in question, may, under favorable circumstances, be sufficient to produce a flow. The principal requisite in this case, in addition to those already mentioned, is that the gravel shall be of such a coarseness that the loss of head in transmission from the edge of the clay bed may not be excessive. On the north shore the outlet of the gravel under the Sound should be more or less completely sealed by an impervious layer.

Distribution.—The principal bed of this character is the Lloyd sand (p. 19), the position of the surface of which is shown on Pl. XVI, from which the position of the bed at any point may be inferred. This horizon has been developed to a very considerable extent on the north shore and at one point on the south shore. The most important wells deriving water from it are the following:

TABLE V. —*Wells in the Lloyd sand.*

No.[a]	Location and owner.	Total depth.	Remarks.
633	Lloyd Neck; Dr. O. L. Jones.....	248	Elevation approximately 5 feet above mean high tide. Flows 5 gallons per minute at high tide.
620	Cold Spring Harbor; T. S. Williams.	430	Elevation 8 feet above mean high tide. Flows 12 gallons per minute.
559	Center Island; C. W. Wetmore....	318	Elevation approximately 5 feet. Flows 25 gallons per minute at high tide.

[a] Numbers correspond with those used in Chapter IV and on index map, Pl. XXIV.

TABLE V.—*Wells in the Lloyd sand*—Continued.

No	Location and owner.	Total depth.	Remarks.
558	Center Island; Colgate Hoyt	320	Elevation approximately 6 feet. Flows.
557	—— S. T. Shaw	292	Elevation approximately 5 feet. Flows 5 to 6 gallons per minute at high tide, flows slightly at low tide.
556	—— C. S. Sherman	351	Elevation approximately 8 feet. Flows 30 gallons per minute at high tide, 20 at low tide.
555	—— G. M. Fletcher	370	Elevation approximately 10 feet. Flows 25 to 30 gallons per minute at high tide.
554	—— G. C. MacKenzie	379	Elevation approximately 10 feet. Flows 75 gallons per minute at high tide, 45 at low tide.
553	Oyster Bay; Emily Roosevelt	460	Flow was obtained at 460 feet, but well was abandoned because of breaking of pipe.
560	Bayville; Dr. O. L. Jones	276	Flows.
564	Mill Neck; Irving Cox	330	Elevation about 12 feet. Flows 72 gallons per minute.
470	Peacock Point; C. O. Gates	230	Elevation approximately 6 feet. Flows 30 gallons per minute.
472	——; do	210	Elevation approximately 15 feet. Flowed when first completed 40 gallons per minute. Is now being pumped.
471	——; do	225	Flows 10 gallons per minute.
473	—— W. D. Guthrie	340	Elevation about 10 feet. Flows 10 gallons per minute.
317	Lake Success; W. K. Vanderbilt, jr.	755	Pumps 300 gallons per minute.
130	Barren Island; Thomas F. White Co.	740	Elevation approximately 7 feet. Flows 103 gallons per minute.
131	Barren Island; New York Sanitary Utilization Co.	724	Elevation 5–7 feet. Flows 50 gallons per minute.
132	——; do	700	Elevation 9 feet. No flow. Pumps 150,000 gallons in 24 hours.

The many wells put down in the Cretaceous beds overlying this horizon have yielded very conflicting results. There seem, however, to be several water-bearing horizons of greater or less importance which can be made available, and which have been overlooked in the earlier work because of the ease with which water could be obtained from the coarse Jameco gravels. A 10-inch well near Lynbrook, 504 feet deep, belonging to the Queens County Water Company, has been very carefully tested and found to yield 450,000 gallons per day. Flowing water has also been obtained at the following places and depths:

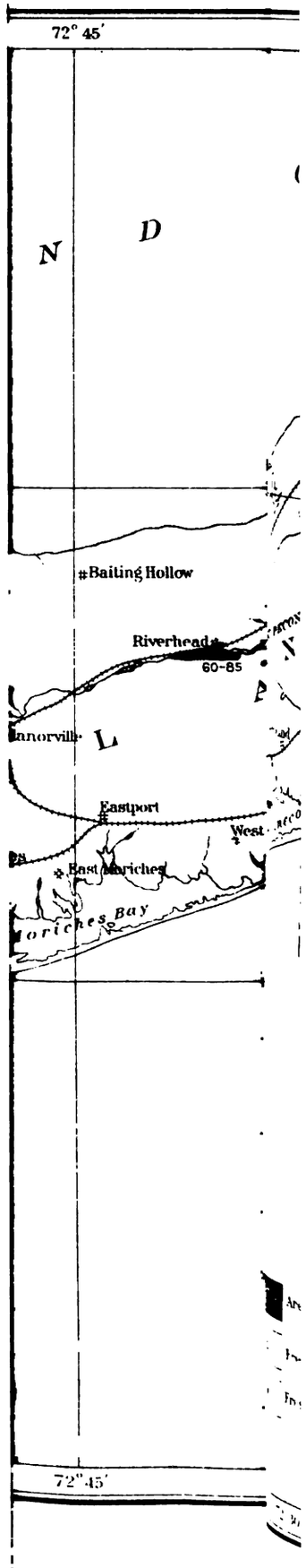
Flowing wells in the Cretaceous on Long Island other than those in the Lloyd sand.

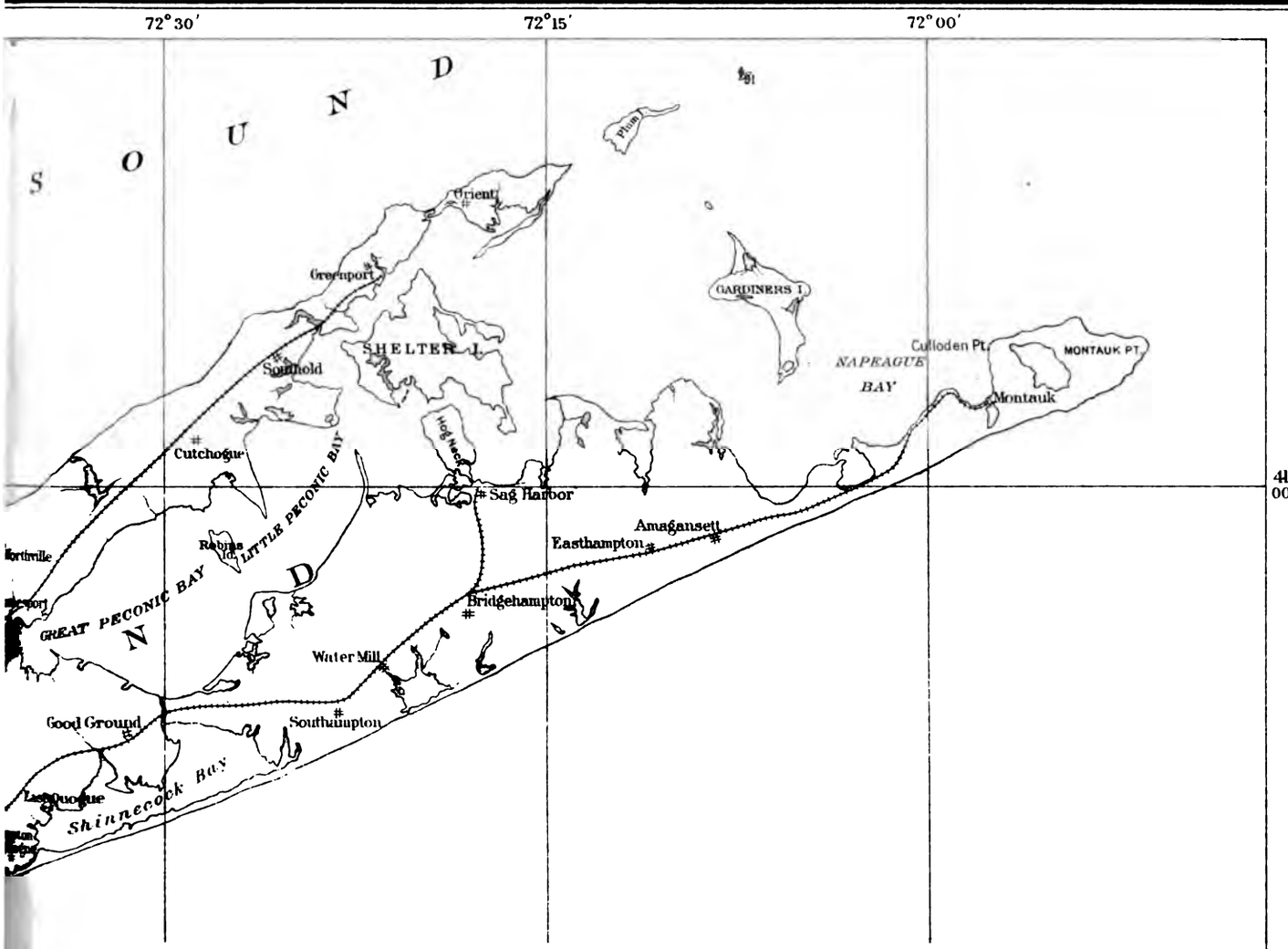
	Depth in feet.
Long Beach	270–383
South of Baldwin	289
Quogue, 3 wells	240
Riverhead	250–330
Setauket	225

None of these wells has been carefully tested, and no definite data can be given regarding their capacity.

HEAD DEVELOPED IN A 40-FOOT ARTESIAN WELL BELONGING TO THE CITIZENS' WATER-SUPPLY COMPANY NEAR DOUGLASTON, N. Y.

Water rises to within 1.5 feet of top of pipe. Box contains automatic gage used in study of the tidal fluctuations in this well.


72° 45'
N
D
#Baiting Hollow
Riverhead
60-85
L
Eastport
West
East Moriches
Moriches Bay
72°45'



MAP OF

LONG ISLAND, NEW YORK,

SHOWING NORTH SHORE AND JAMECO ARTESIAN WELL AREAS

By A.C. Veatch
1904

Scale

5 0 5 10 15 miles

LEGEND

- Areas of artesian or flowing water
- Fresh water not flowing
- Fresh water flowing
- Salt water not flowing
- Salt water flowing
- Unsuccessful
- 150 — Figures give total depth or depth of major flow in deep wells, bottom of the Jameco

JULIUS BIEN & CO. LITH. N.Y.

Like the other artesian wells on Long Island, water from the Cretaceous horizons will seldom rise higher than 5 to 10 feet above sea level, and artesian wells are therefore restricted to the region of the shore.

Predictions.—The Lloyd gravel is the best-defined artesian horizon on the island and is believed to be remarkably persistent. It may be regarded as available south and east of a line connecting Bay Ridge and Willets Point to, perhaps, somewhat beyond Riverhead, and will furnish flowing water at elevations less than 5 to 10 feet above sea level. The importance of this horizon on the North and South flukes is uncertain because of the distance from the main uplands of the island. The South Fluke, however, is the more promising territory, because it is down the dip and has a greater area. The minor upper horizons are not so well known and their positions can not be definitely predicted.

REQUISITE CONDITIONS FOR SUCCESSFUL WELLS ON LONG ISLAND.

Were Long Island composed of entirely homogeneous porous materials it would be necessary to sink wells only slightly below the main ground-water table, a distance of 25 or 30 feet probably being all that would be required in any case. The great irregularity of the formations, however, introduces a new factor. For a permanent well it is not only necessary to go to the main ground-water table, but to land the well in a coarse bed from which water will be given up freely. It is this point that makes well sinking on the island somewhat uncertain. In general it is not necessary to go far below the main water table (fig. 24), but in some cases, notably in the Wheatley Hills, the beds at the water table and for some distance below are so fine that they pass the strainers and fill the well with quicksand. In these cases it was necessary to drill until a coarser bed was reached, which in the Morgan well (431) was 100 feet and in the Duryea well (430) was about 140 feet below sea level, the main water table being in both cases about 85 feet above sea level. In the Vanderbilt well (317), although the main water table was encountered at about 50 feet above sea level, the well was pushed to a depth of 585 feet below sea level, completely penetrating the coarse Lloyd gravel, from which an abundant supply was obtained.

One very significant point in regard to these deep wells in the higher parts of the island is that the height to which the water will rise never exceeds the height of the main water table, and generally falls slightly below it. The point, then, in going deeper, except near the shores where artesian conditions are present, is not to get an increase in head, but to find a coarse layer which will readily yield water; in other words, to find an extensive natural horizontal strainer which will aid in separating the water from the adjacent fine sands.

SOURCE OF THE UNDERGROUND WATER ON LONG ISLAND.

The gradual decrease in head, with depth which is observable in deep wells in the center of the island, is an important matter in the consideration of the source of the water. Thus in the Vanderbilt well (317) while the main water table was encountered at 54 feet above sea level, the height to which the water rose from the Lloyd gravel was only 35 feet, a loss of 20 feet of head in about 550 feet of depth. This height is, moreover, greater than that to which the water will rise from the

same horizon on the north and south shores. If the water came from below, as is very generally imagined, the pressure should decrease from bed rock upward for an appreciable distance, the pressure near bed rock being greater because of the loss in head in transmission through the sand; while if the water came from above it would be expected that the head would either remain the same or decrease with the depth. As it decreases it furnishes conclusive proof of the insular source of the water.

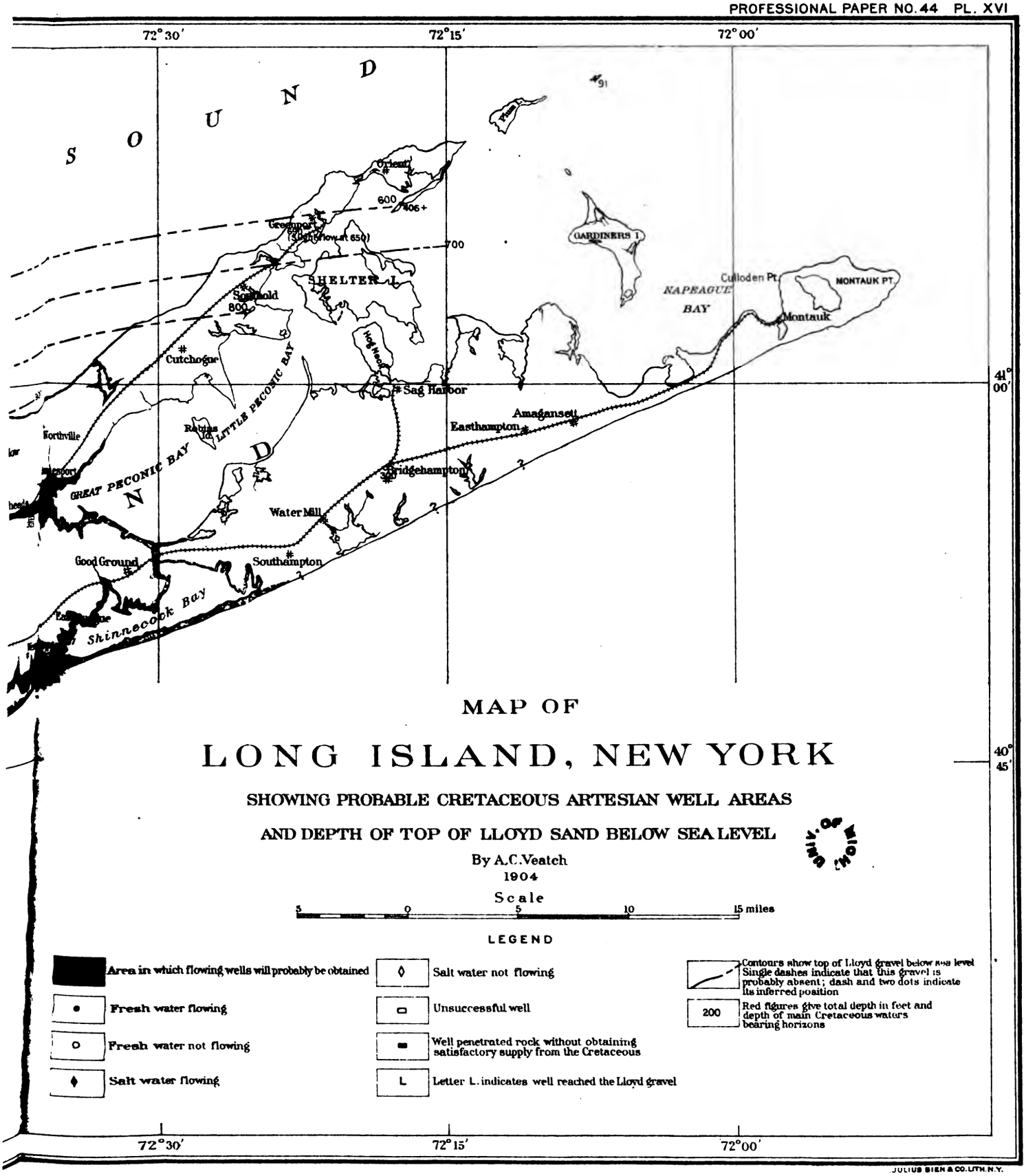
The geologic structure of the region (fig. 24), moreover, forbids the transportation of water from New England, except through bed rock, and the metamorphosed and highly folded character of these beds makes such transmission very doubtful. Early in the consideration of the possible reason for the deep flowing wells from the Lloyd gravel, after it had been found that the Cretaceous beds dip regularly southward, and before it was known that the clay beds were not continuous, it was suggested by Prof. W. H. Hobbs, of the University of Wisconsin, and Prof. H. E. Gregory, of Yale University, that if the faulted structure found in Connecticut continued under Long Island, and if the fault springs which are common in the former region were present, then the water furnished by these springs would be retained beneath the clay layer and give rise to an artesian condition. Fault springs, or natural artesian wells, produced under the proper conditions by the cutting of a porous water-bearing layer by a fault line, are comparatively simple phenomena, but the hypothesis that such springs occur under Long Island must rest on the assumption of a complexity of horizontal faulting of which there is no evidence. Moreover, the water obtained from these deep wells runs exceptionally low in chlorine, alkalinity, and hardness, while waters from the rock wells in the western part of the island and in neighboring regions of New York and Connecticut have, as a rule, a much higher mineral content.

TABLE VI.—*Analyses showing difference between waters from the Lloyd sand and those from the rock wells of Connecticut.*

[Parts per million.]

Location	Chlorine.	Hardness.	Alkalinity.	Analyst.	Remarks.
Center Island, Long Island (559).	3.54	20.0	19.0	C. S. Slichter	Flowing well in Lloyd sand; 318 feet deep.
Center Island, Long Island (556).	3.89	20.0	18.7	.....do	Flowing well in Lloyd sand; 351 feet deep.
Center Island, Long Island (554).	4.25	20.0	20.0	.....do	Flowing well in Lloyd sand; 378 feet deep.
Peacock Point, Long Island (470).	5.83	27.5	27.2	.....do	Flowing well in Lloyd sand; 230 feet deep.
Lattingtown, Long Island (473).	4.60	22.5	17.5	.....do	Flowing well in Lloyd sand; 342 feet deep.
Long Island City (75)	1,902.1	.....	.....	Jacob Blumer, Oct. 12, 1888	Well in rock; 275 feet deep.
Connecticut:					
Greenwich	9.28	10.7	.....	H. T. Vulté	Well in rock; 177 feet deep.
Rowayton	32.00	.....	22.0	H. E. Smith	Well in rock; 395 feet deep.
Norwalk	25.0	62.9	.....	S. P. Wheeler	Artesian well.
Norwalk	20.0	60.0	.....	.....do	Do.
Norwalk	5.6	45.7	.....	.....do	Do.
Westport	12.0	74.3	.....	.....do	Do.
Fairfield	31.0	121.0	.....	.....	
Fairfield	21.0	164.3	.....	S. P. Wheeler	Do.

72° 45'
N
D
900
#Baiting Hollow
Riverhead
Manorville
L
Eastport
Moriches Bay
72° 45'



MAP OF

LONG ISLAND, NEW YORK

SHOWING PROBABLE CRETACEOUS ARTESIAN WELL AREAS

AND DEPTH OF TOP OF LLOYD SAND BELOW SEA LEVEL

By A.C. Veatch

1904

Scale

5 0 5 10 15 miles

LEGEND

- Area in which flowing wells will probably be obtained
- Fresh water flowing
- Fresh water not flowing
- Salt water flowing
- Salt water not flowing
- Unsuccessful well
- Well penetrated rock without obtaining satisfactory supply from the Cretaceous
- L — Letter L. indicates well reached the Lloyd gravel
- Contours show top of Lloyd gravel below sea level. Single dashes indicate that this gravel is probably absent; dash and two dots indicate its inferred position
- 200 — Red figures give total depth in feet and depth of main Cretaceous waters bearing horizons

JULIUS BIEN & CO. LITH. N.Y.

TABLE VI.—*Analyses showing difference between waters from the Lloyd sand and those from the rock wells of Connecticut*—Continued.

Location.	Chlorine.	Hardness.	Alkalinity.	Analyst.	Remarks.
Connecticut—Continued.					
West Bridgeport	26.0	167.5	.....	S. P. Wheeler	Artesian well.
Bridgeport	32.9	60.0	.....	....do	Rock well; 125 feet deep.
East Bridgeport	7.0	36.4	.....	....do	Artesian well.
Woodmont	28.7	56.0	.....	H. E. Smith	Rock well; 52 feet deep.
Deep River	5.5	54.0	.....	R. B. Riggs	Artesian well.
Niantic	9.1	15.0	.....	A. B. Bryant	Deep artesian well.
Middletown	14.5	160.0	.....	....do	Do.
Hartford	6.6	28.5	.....	Henry Souther	Artesian well; 350 feet deep.
Hartford	22.5	(a)	.....	.....	Artesian well; 242 feet deep.
Hartford	13.0	24.0	.....	H. E. Smith	Artesian well; 250 feet deep.
Hartford	11.0	72.9	.....	S. P. Wheeler	
Hartford	30.7	128.6	.....	R. B. Riggs	Artesian well.

[a] Very hard.

On the whole, there is absolutely no evidence of a Connecticut source for the underground water on Long Island. The water is derived entirely from rainfall on the island, and all the water phenomena observed can be directly traced to this source, except that a slight amount may be transmitted through the Lloyd gravel from New Jersey.

CAUSES OF FLUCTUATION OF THE GROUND-WATER TABLE.[a]

The causes which produce fluctuations of the ground-water table on Long Island may be subdivided as follows:

A. Natural:
- Rainfall.
- Sympathetic tides.
- Thermometric changes.
- Barometric changes.

B. Artificial:
- Dams.
- Pumping.

NATURAL CAUSES OF FLUCTUATION.

Rainfall.—As rainfall is the source of ground water, it would seem self-evident that the ground-water level must vary directly with the rainfall, heavy rains raising it and long periods of drought lowering it. While this is true in a broad way, the relation between the rainfall and the changes in level of the ground-water table is not such a simple one as this statement might imply.

In the summer of 1903 the engineers of the Long Island division of the commission on additional water supply made daily observations on the water levels in wells in many parts of Long Island and accumulated much definite data on this point. Fortunately the observations began just before the exceptional period of drought which extended from April 16 to June 7. The wells observed were

[a] Preliminary statement; a more complete report on the observations on these fluctuations made during the summer of 1903 is now in press as Water-Supply and Irrigation Paper No. 155.

largely open dug wells depending on the main ground-water level, which, as already indicated, rises from sea level on each side of the island to a summit somewhat north of the surface divide (p. 57).

From these records the typical hydrographs shown on Pl. XVII have been selected. This group of wells, with the possible exception of No. 6, are all south of the ground-water divide and in a region where the direction of underflow is southward.

In shallow wells near the south shore, such as Nos. 1 and 2, the relation between the rainfall and the fluctuation of the ground-water table is very apparent.

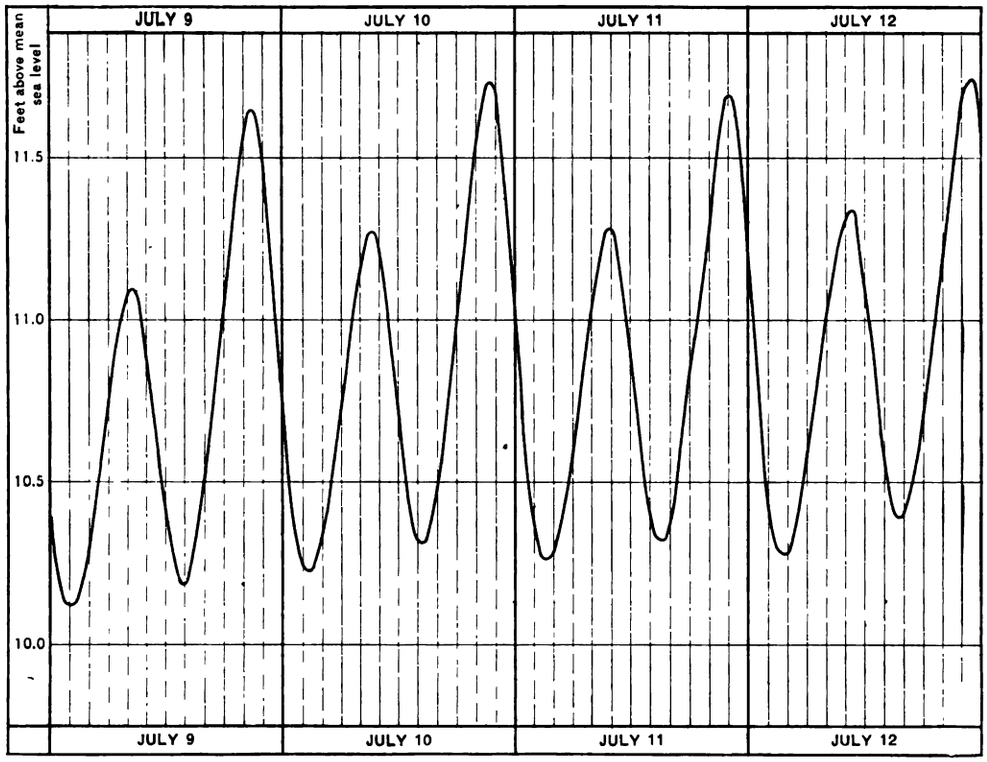
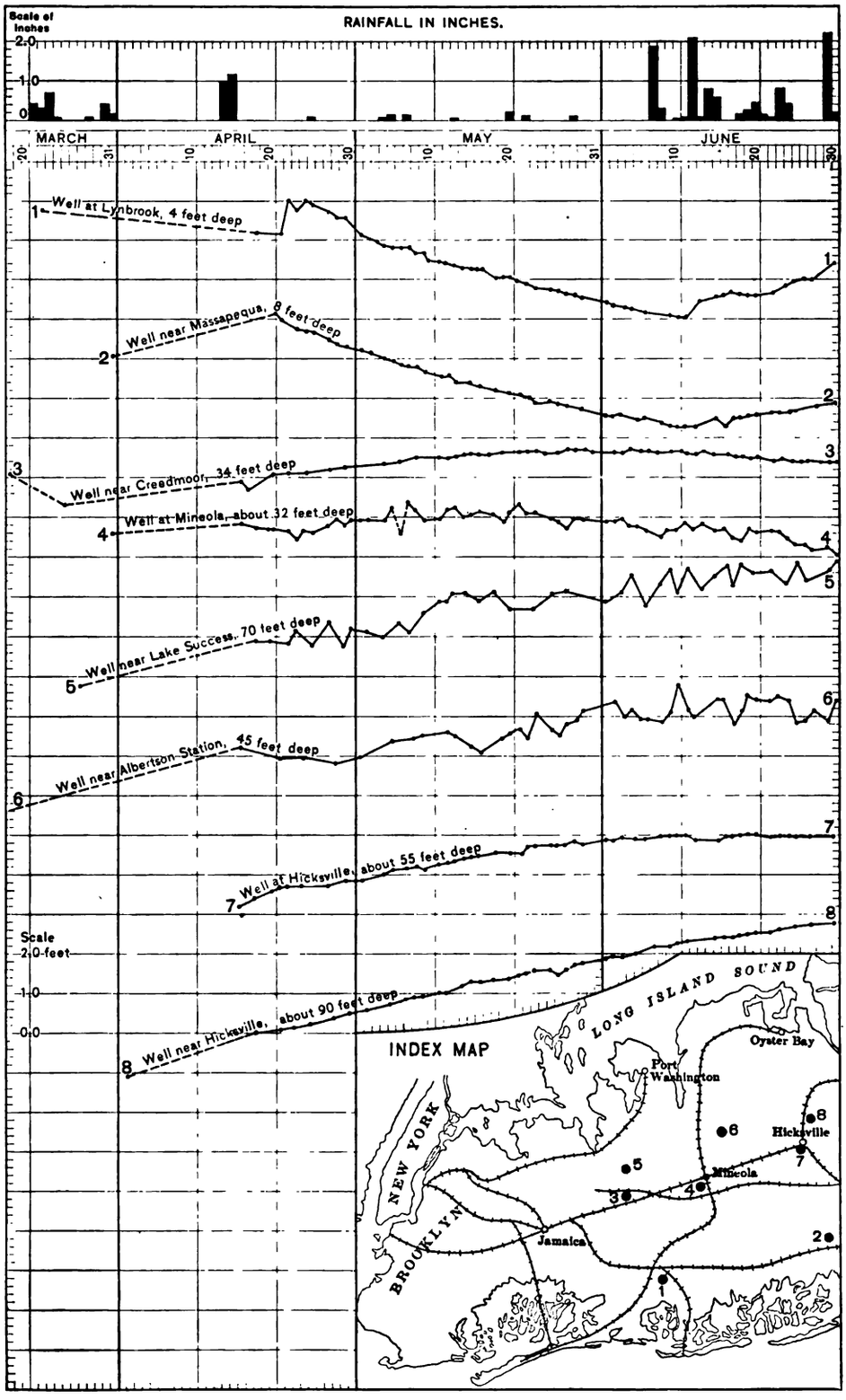


FIG. 34.—Autograph record of water level in a 386-foot well at Long Beach, N. Y., showing fluctuations due to tides. Record from a Means nilometer in charge of F. D. Rathbun, field assistant. Elevations indicated are approximate.

Five or six days after the heavy rains of April 14 and 15 the water, after rising for a few days, fell steadily through the period of dry weather. Three or four days after the rain of June 7, which ended the drought, the water in both wells began to rise and continued to rise during the rainy weather which followed.

Farther inland, a gradual change is noted in the behavior of the surface of the ground-water, wells 7 or 8 miles from the shore, such as Nos. 3, 4, and 7, showing an entirely different curve. In these the water rose steadily during the drought and began to fall when the heavy rains commenced. In wells still farther inland, as Nos. 5, 6, and 8, the water rose steadily for the whole period shown,



FLUCTUATIONS OF THE MAIN GROUND-WATER TABLE ON LONG ISLAND.

From obeervations of the Long Island division of the New York City commission on additional water supply, March-June, 1903.

well No. 8 actually rising over 2 feet during the greatest drought this section had ever experienced.

These curves indicate that the deeper the ground-water table and the farther it is from the shore (or the higher it is above sea level) the more slowly it responds to the rainfall. The retardation is entirely out of proportion to the thickness of the unsaturated beds above the main water table. In the wells at Lynbrook and Massapequa, which are from 4 to 8 feet deep, rain water should, according to the rate of flow determined by laboratory tests, reach the ground-water table in a few minutes, yet the water table did not begin to rise until four or five days after the heavy rains. As the thickness of the unsaturated beds increases, this retardation is multiplied at an astonishing rate. Thus, while the 4 and 8 foot wells at Lynbrook and Massapequa began to fall seven days after the close of the rainy period in April, the 32-foot well at Mineola did not begin to fall until after thirty-five days, the 34-foot Creedmoor well after about fifty-five days, and the 55-foot Hicksville well after about sixty-five days, while the 70- and 90-foot wells at Lake Success and Hicksville showed no tendency to fall after seventy-five days, but were still rising from the effects of the March and April rains. In this delayed transmission the effects of single showers is almost wholly neutralized, the sand acting as so perfect an equalizer that only the mass results of long periods of rain or drought are indicated. The question involved here is apparently not so much how fast a constant stream of water under a given pressure will flow through a column of earth of a given height as how long it will take a given quantity of water precipitated on the top of this column during a relatively short time to entirely or almost entirely run out at its base.

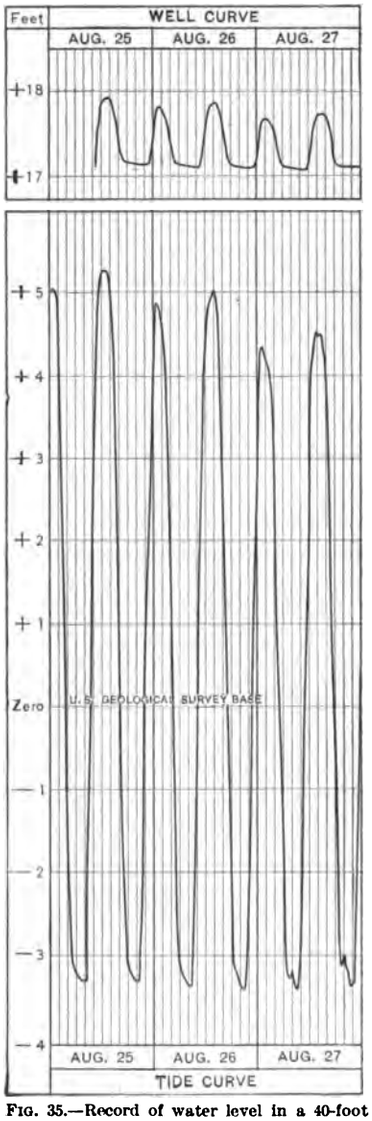


FIG. 35.—Record of water level in a 40-foot well of the Citizens' Water Supply Company at Douglaston, N. Y., and tidal record in adjacent creek. Record from Friez tide gages in charge of F. L. Whitney, field assistant.

Tides.—Nearly all the wells in the neighborhood of the shores, both shallow and deep, show a sympathetic vibration with the tides. The nature of this vibration and its clearly tidal character are shown in figs. 34 and 35. Fig. 34 represents a 386-foot well at Long Beach and fig. 35 a 40-foot well at Douglaston. This fluctuation is commonly greatest at the shore and becomes less on passing inland, but this rule is by no means invariable, and many very peculiar local variations are found.

The tidal curves in the wells are miniatures of those in the near-by body of water, but are generally somewhat behind them. Thus, at Oyster Bay, where the water is under sufficient hydraulic head to lift it considerably above the surface of the ground (see Pl. XIII, *A*), the tide in the Casino well, which is in the very edge of the water, is five to ten minutes behind that in the bay, while in the Underhill well, which is only 300 feet from the shore, it shows a lag of from sixty-five to seventy-five minutes.

While this great increase in the amount of lag in very small distances indicates that the factors concerned in the formation of these sympathetic tides are rather complex, it is not felt that the phenomenon necessarily involves a free outlet of the underground water into the ocean, as is very commonly held in this region. On the contrary, it is thought to be conceivable that the clay layers, rendered more or less sensitive by the water-logged artesian sands beneath them, may act as large diaphragms and respond directly to the alternate loading and unloading caused by the flood and ebb tides.

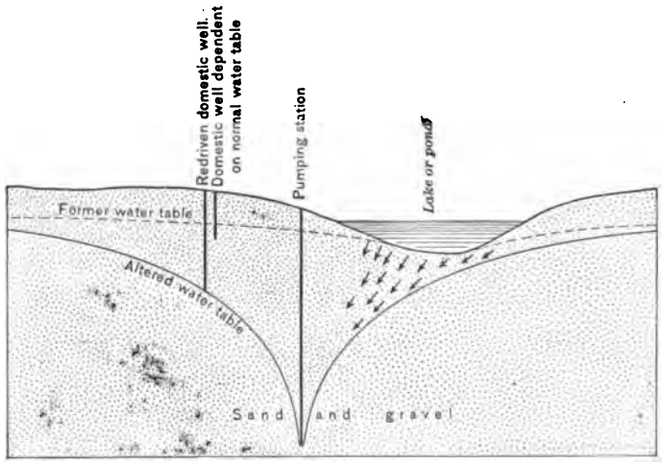


FIG. 36.—Diagram showing cone of depression produced by a pumping station and its effect on a near-by pond or well.

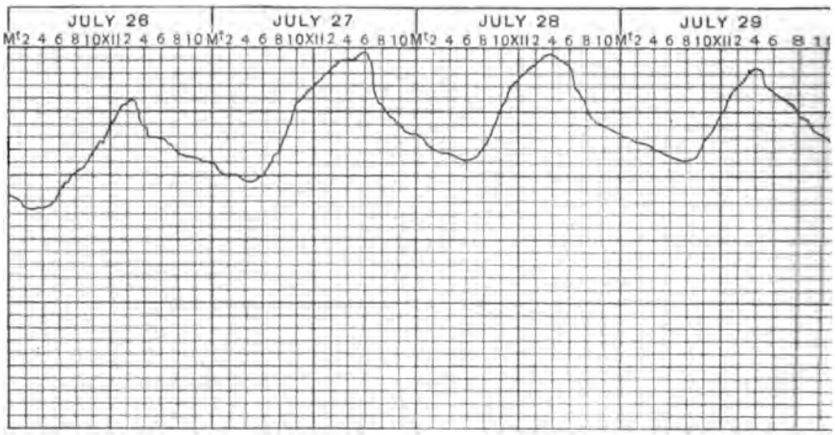
Thermometric and barometric changes. — Self-recording gages placed on the wells of the Queens County Water Company at Lynbrook (277) during the summer of 1903 showed very regular daily fluctuations of the ground-water table, which were clearly due neither to rainfall nor tidal action. A comparison of these curves with the thermograph and barograph records obtained at Floral Park and Brentwood by the commission on additional water supply (Pl. XVIII) shows that the fluctuations closely correspond to the changes in temperature and only remotely to those of air pressure, except in the case of the 504-foot well. It was at first thought that the daily fluctuations in the temperature might produce minor barometric fluctuations and that the changes in the water level might be ultimately due to changes in air pressure, but a study of the data forces the conclusion that the normal fluctuation shown in curves 1 and 2 are directly due to temperature. Thus the important barometric depression indicated on July 26 produced no effect on the water level in the 14- and 72-foot wells, although clearly noticeable in the 504-foot well. Even the sudden rise of the water, which occurred during the storm of July 30 and which has many aspects of being due to a change in air pressure, has a sharpness and definition not indicated by the barograph curve, although suggested by the thermograph curve.

U. S. GEOLOGICAL SURVEY

1903.

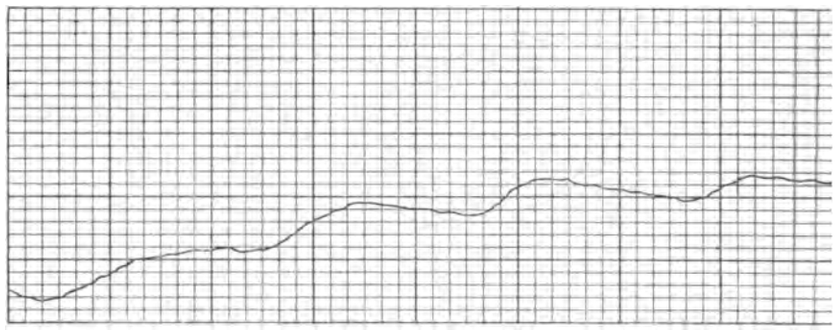
I

Autographic record of fluctuations of water surface in 14-foot well at Lynbrook, New York. (Inverted curve)



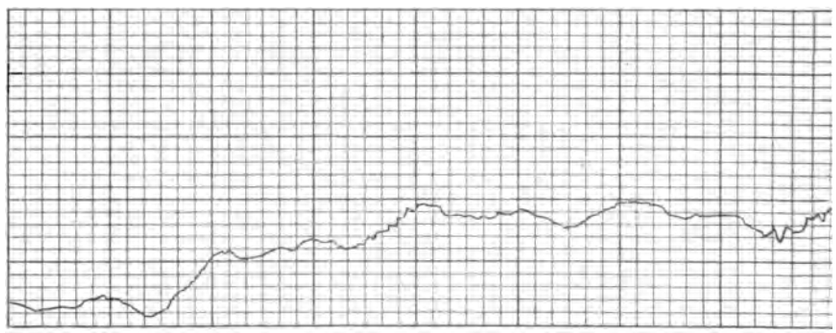
II

Autographic record of fluctuations of water surface in 72-foot well at Lynbrook, New York. (inverted curve)



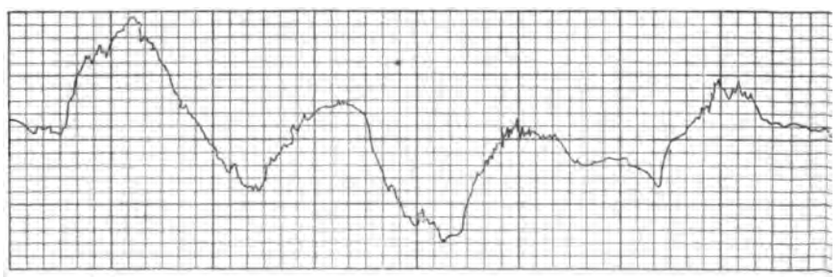
III

Autographic record of fluctuations of water surface in 504-foot well at Lynbrook, New York. (inverted curve)



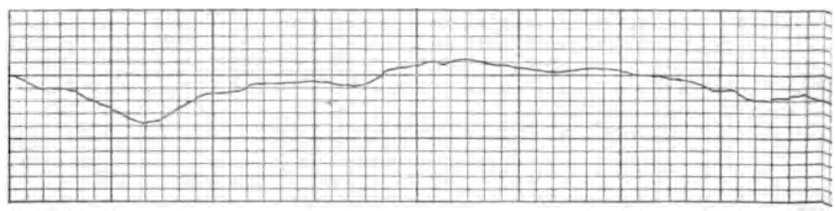
IV

Thermograph curve at Floral Park, New York.



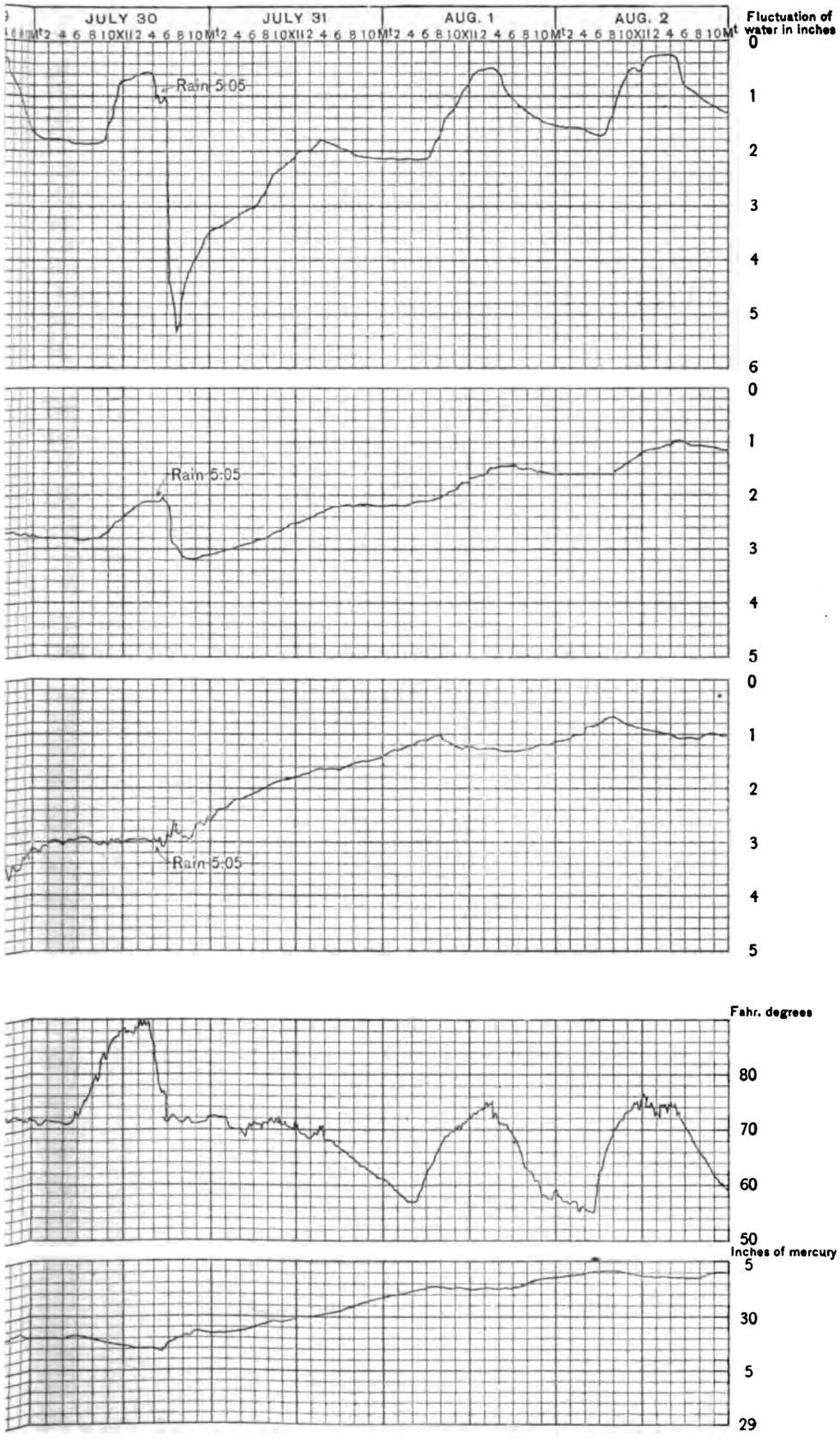
V

Barograph curve at Brentwood, New York.



EXAMPLES OF FLUCTUATIONS DUE TO THE

Records at Lynbrook from King self-recording instruments in charge of F. L. Whitney, field assistant. Rec



THERMOMETRIC AND BAROMETRIC CHANGES.

Records at Floral Park and Brentwood from records of the commission on additional water supply.

ARTIFICIAL CAUSES OF FLUCTUATION.

Dams.—The first important cause producing a change in the normal level of the ground-water table was the construction of dams for mill purposes. These, without exception, raised the ground-water table and decreased the spring flow in the valley above the points at which they were constructed (see p. 62). The crest flow in every case was less than the normal flow of the stream at the same point. The enlargement of these ponds for storage purposes by the Brooklyn waterworks but emphasized this condition.

Pumping.—When pumping stations were established a diametrically opposite effect was produced. A pumping station instead of hindering the outward flow of the water helps it, and as the group of wells connected with a pumping station is usually restricted to a relatively small area, a more or less symmetrical cone of depression is produced with the group of the wells as a center. All wells, springs, and ponds which depend on this main water table and which are in the radius of the cone of depression are directly influenced. As a result preexisting wells have had to be driven to a depth slightly greater than that of the new water table (fig. 36), the spring flow is decreased, and adjacent ponds and marsh areas are more or less completely drained. Mr. L. B. Ward has compiled the following table showing the decrease in stream flow on southern Long Island between 1873 and 1899, which must be largely due to the effect of the pumping stations:

TABLE VII.—*The effect of ground-water pumping in diminishing stream flow from 1873 to 1899 in the old watershed of the Brooklyn waterworks, comparing five-year periods.*

[By L. B. Ward.]

Period.	Average annual rainfall.	Average annual rainfall collected, referred to watershed as a whole.		Area of watershed.	Driven-well supply.		Other pumped sources of supply.		Daily total per square mile derived from all sources in the watershed.	Water collected as stream flow, referred to 50 square miles of watershed.		
					Expressed as rainfall.	Daily per square mile.	Expressed as rainfall.	Daily per square mile.		Daily per square mile.	Expressed as rainfall.	
											Amount.	Proportion of total.
	Inches.	*Per cent.*	*Inches.*	*Square miles.*	*Inches.*	*Gallons.*	*Inches.*	*Gallons.*	*Gallons.*	*Gallons.*	*Inches.*	*Per cent.*
1873–1877.....	43.33	25.07	10.86	52.30	(a)	(a)	0.18	8,659	517,206	532,034	11.17	25.79
1878–1882.....	41.58	29.60	12.31	55.14	(a)	(a)	.99	47,063	585,978	594,310	12.48	30.02
1883–1887.....	43.30	31.60	13.68	64.42	2.95	140,392	2.30	109,041	651,506	518,071	10.88	25.13
1889–1893.....	45.05	38.43	17.31	65.54	5.85	278,383	4.17	198,605	824,195	455,153	9.56	21.22
1895–1899.....	43.14	36.32	15.67	66.44	7.76	369,581	2.74	130,224	745,983	327,122	6.89	15.96

a Began in 1883.

While a decrease in spring flow must follow any extensive method of removing the ground water in this region, it should be borne in mind that the cost of such a removal will probably be less than its collection from surface ponds and the subsequent filtration which must necessarily follow. A subterranean system will, moreover, result in the more or less complete reclamation of the swampy lands along many of the brooks.

The effect which the lowering of the ground-water table by a few feet in this region may have on farm products is not very clear. It is certainly true that

plants thrive where the ground-water table is 25 to 100 or more feet below the surface, and it is difficult to see how the lowering of the water table a few feet will very definitely affect farm products, except where it makes swamp land cultivable.

BLOWING WELLS.

Mr. William Jaegle, a well driller of Hicksville, reports a number of blowing wells about Woodbury (519, 588, 589, 590). These blow intermittently, generally before a storm, and are clearly very similar to the blowing wells reported from the Western States.[a]

The cause of this blowing seems to a large extent to be due to changes in barometric pressure, an outflow of air occurring when the surface pressure is relatively low, and an inflow when it is relatively high.

A careful examination was made of the wells at Woodbury by Mr. R. D. Rathbun, field assistant, with a view to attaching a recording instrument and carefully studying this phenomenon, but the conditions were found not to be favorable.

WATERWORKS.

The porous nature of Long Island, which causes it to readily absorb, filter, and store the rain water, admirably fits it for furnishing large quantities of very pure water.

As has been pointed out, the total loss by evaporation is relatively small, and the run-off is almost wholly that supplied by springs. These short, steady-flowing, spring-fed streams, which were first utilized for small saw and grist mills, were the most natural source for water when the growing city of Brooklyn began to demand a water supply.

The original Brooklyn system, completed in 1862, derived its supply wholly from a number of surface streams between Brooklyn and Lynbrook, which were intercepted by a conduit in which the water flowed by gravity to Ridgewood, where it was lifted into reservoirs which supply a simple gravity system. As the demand increased, it became necessary to utilize other ponds and streams which were too low to flow naturally into the conduit, and in 1872 pumping stations were established at Watts Pond and Smiths Pond.

In the same year a private system supplied by springs was established at Sea Cliff. This was the first waterworks plant on Long Island after the Brooklyn system. In 1874 plants were completed by three villages: College Point, Flushing, and Long Island City; of these, the first two depended on spring and stream supply, and the last on a single large well. This last was the first plant using the ground water as a source of supply. Garden City followed in a few years with a system depending on a single large well.

In 1880 the surface supply of the Brooklyn waterworks was supplemented by open-well stations at Springfield and Watts Pond, and in 1882 gang-well stations were established at Spring Creek and Baisleys. Since that time the

[a] Water-Sup. and Irr. Paper No. 67, U. S. Geol. Survey, 1902, pp. 72, 73; Nebraska Geol. Survey, vol. 1, 1903, pp. 93-97; Water-Sup. and Irr. Paper, No. 101, U. S. Geol. Survey, 1904, pp. 60-61.

development of the ground water has been comparatively rapid; many local plants have been erected, which, with scarcely an exception, depend on wells. Of the plants of the five cities—Brooklyn, College Point, Flushing, Sea Cliff, and Northport—which originally depended largely on surface water, the last three now depend wholly on wells. The plans for the change of the College Point (Fresh Meadow station) to a driven-well plant have been approved, and Brooklyn has so supplemented her supply by driven-well stations that at present only about two-thirds of the supply is derived from surface waters. At Sag Harbor it has been found advisable to abandon the wells, and the plant there is now the only one on the island wholly dependent on a surface supply.

The amount of water taken from Long Island for waterworks purposes during 1902 may be roughly estimated at 120,000,000 gallons per day, of which 65,000,000 was from springs or spring-fed streams and 55,000,000 was from wells. The Brooklyn Water Company consumed almost the whole of the surface water utilized and slightly more than 50 per cent of the well water.

The distribution of the various water systems on Long Island, the area covered by each, and the location of the pumping stations and other sources of supply, are shown on the accompanying map (Pl. XIX). Other data are presented in the following table and in the detailed records given on pages 116–337.

17116—No. 44—06——6

TABLE VIII.—*Waterworks*

No.[a]	Owner.	Description.	Coordinates (b)	Service began.	Source of supply.	Estimated capacity of station per day.	Average yield per day for year given in last column.		
							Wells.	Springs.	Streams[c]
						Gallons.	*Gallons.*	*Gallons.*	*Gallons.*
	New York City, department of water supply, gas, and electricity (Borough of Brooklyn).	.....	.....	1858	Driven wells and streams.	[d]125,000,000	.....	.....	.....
15	.....do.....	New Utrecht station.	2 B.	[i] 1885	120 2-inch wells, 30 feet deep.	2,000,000	1,120,596	.....	.....
16	.....do.....	Gravesend station	2 B.	.....	113 2-inch wells, 50 feet deep.	2,600,000	2,444,032	.....	.....
135	.....do.....	New Lots station.[l]	3 C.	1881	22 2-inch wells, 45 to 50 feet; 14 6-inch wells, 80 to 90 feet; 4 6-inch wells at bottom of 1 open well, 29 by 24 feet.	.....	4,330,600	.....	.....
140	.....do.....	Ridgewood station.	3 C.	1862	Ridgewood aqueduct; force main from Millburn.	.....	28,581,383	.....	63,761,017
138	.....do.....	Spring Creek (old)	3 C.	1882	100 2-inch wells, 36 feet deep; 1 6-inch well, 150 feet deep; 7 8-inch wells, 150 feet deep.	5,000,000	3,973,160	.....	.....
139	.....do.....	Spring Creek (temporary).	3 C.	1894	13 6-inch wells, 42 to 75 feet deep.	4,500,000	2,997,945	.....	.....
194	.....do.....	Shetucket station.	4 B.	1897	12 8-inch wells, 195 feet deep.	3,500,000	1,678,219	.....	.....
198	.....do.....	Oconee station ...	4 C.	1897	12 8-inch wells, 195 feet deep.	2,500,000	1,634,408	.....	.....
200	.....do.....	Baisley's station .	4 C.	1882	100 2-inch wells, 44 feet deep.	2,500,000	1,527,051	.....	.....
	.....do.....	Baisley's supply pond.	4 C.	[m] 1858	Surface water.....	6,000,000	.....	.....	6,000,000
201	.....do.....	Jameco station...	4 C.	1888	16 8- and 10-inch wells, 160 feet deep; 183 2-inch wells, 27 to 73 feet deep; 4 4-inch wells, 160 feet deep; 3 6-inch wells, 153 feet deep.	6,000,000	4,935,482	.....	.....
196	.....do..... ...	Springfield station.	4 B.	1880 [n] 1897	20 8-inch wells, 170 feet deep.	.....	2,133,890	.....	.....
	.....do.... ..	Springfield Pond .	4 B.	1880	Surface water.....	2,000,000	.....	.....	2,000,000
290	.....do.....	Forest Stream station	5 B.	1885	110 2-inch wells, 41 feet deep.	5,000,000	3,439,039	.....	.....
	.....do.....	Simonson's supply pond.	5 C.	1862	Surface water.....	.....	.....	.....	2,000,000
	.....do.....	Clear Stream supply pond.	5 C.	1862	.....do.....	200,000	.....	.....	200,000
288	.....do.....	Clear Stream station.	5 B.	1885	150 2-inch wells, 38 feet deep.	5,000,000	2,568,055	.....	.....
	.....do.....	Watts Pond.....	5 B.	[o] 1872	Surface water.....	.....	.....	.....	840,000
286	.....do.....	Watts Pond station.	5 B.	1872 [n] 1894	Watts Pond ..... 12 6-inch wells, 50 feet deep.	2,500,000 2,500,000	[p]2,213,703	.....	1,000,000
	.....do.....	Valley Stream supply pond.	5 C.	1862	Surface water.....	1,300,000	.....	.....	.....

[a] Numbers correspond to those used in the detailed records in Chapter IV and in the index maps, Pls. xix, xxiv.
[b] See Pls. xix, xxiv.
[c] Streams are all very short and spring fed, and differ very little from springs.
[d] Whole system.
[e] Ridgewood.
[f] Mount Prospect.
[g] Mount Prospect standpipe.
[h] 1899.
[i] Original station established in 1880.

systems on Long Island.

Delivery of water.	Reservoir or standpipe. Capacity.	Reservoir or standpipe. Size.	Elevation of reservoir or standpipe.	Miles of mains.	Fire hydrants.	Authority.	Date.	No.[a]
	Gallons.	*Feet.*	*Feet.*					
Gravity and direct pumping.	[e] 304,000,000 [f] 19,185,000 111,500	64.4 by 16	[e] 170 [f] 198.5 [g] 204–278.4	[k] 597		I. M. De Varona..... L. B. Ward.....	1899	
Direct, connecting with Mount Prospect reservoir.		(*j*)		[k] 35		L. B. Ward.....	1899	15
Direct.....				[k] 17	[k] 144			16
Direct service, connecting with reservoir.			194	[h] 49		L. B. Ward.....	1899	135
Ridgewood reservoir.....	304,000,000		170			.....do.....	1899	140
Ridgewood aqueduct.....						.....do.....	1899	138
.....do.....						.....do.....	1899	139
.....do.....						.....do.....	1899	194
.....do.....						.....do.....		198
.....do.....						.....do.....		200
Not used.....						I. M. De Varona.....	1896	
Ridgewood aqueduct.....						L. B. Ward.....	1899	201
.....do.....						.....do.....	1899	196
Springfield station.....	7,199,000		5.08 1.74			I. M. De Varona.....	1896	
Ridgewood aqueduct.....						L. B. Ward.....	1899	290
.....do.....	9,879,000		13.11 7.05			I. M. De Varona.....	1894	
.....do.....	977,500		13.19 10.19			.....do.....	1894	
.....do.....						L. B. Ward.....	1899	288
.....	3,750,000		6.5 2.7			I. M. De Varona.....	1894	
Ridgewood aqueduct.....						L. B. Ward.....	1899	286
.....do.....	10,850,000		14.58 10.5			I. M. De Varona.....	1896	

[j] 250 feet high, 16 and 8 feet in diameter. Not used.
[k] In 1896.
[l] Formerly Long Island Water Supply Company.
[m] Sole source of supply from November, 1858, to July, 1860.
[n] Driven-well station installed.
[o] Temporary station; permanent station established in 1880.
[p] Allowing 1,000,000 for yield of Watts Pond.

TABLE VIII.—*Waterworks*

No.[a]	Owner.	Description.	Coordinates (b)	Service began.	Source of supply.	Estimated capacity of station per day.	Average yield per day for year given in last column.		
							Wells.	Springs.	Streams [c]
						Gallons.	*Gallons.*	*Gallons.*	*Gallons.*
	New York City, department of water supply, gas, and electricity (Borough of Brooklyn).	Smiths Pond	6 B.	1872	Surface water	4,500,000			
	do	Smiths Pond station.	6 B.	1872	Smiths Pond				8,517,299
	do	Pine's supply pond.	6 C.	1862	Surface water	600,000			
	do	Schodack Brook	6 C.	1873	do	1,000,000			
	do	Hempstead supply pond.	6 C.	1862	do				
	do	Hempstead storage reservoir.	6 C.			8,000,000			8,000,000
	do	Millburn reservoir	6 B.						
	do	Millburn pumping station.	6 B.		Streams, Millburn to Massapequa.				30,450,000
					Streams, Millburn to Massapequa, and driven-well stations given below.		3,114,739		36,974,474
	do	Millburn supply pond.	6 B.	1892	Surface				
	do	East Meadow supply pond.	7 B.		do				
487	do	Agawam station	7 B.	1896	32 6-inch wells, 33 to 91 feet deep.	[d] 4,518,951	520,305		
489	do	Merrick station	7 B.	1896	62 4½-inch wells, 40 to 100 feet deep.	[d] 4,693,432	325,813		
	do	Matowa (new bridge) supply pond.	7 BC	1892	Surface				
491	do	Matowa station	7 B.	1896	46 4½-inch wells, 38 to 97 feet deep.	[d] 4,495,622	890,939		
	do	Wantagh supply pond.	7 C.	1892	Surface				
	do	Seaman's supply pond.	7 C.	1892	do				
493	do	Wantagh station.	7 C.	1896	43 4½-inch wells, 24 to 89 feet deep; 6 6-inch wells, 92 feet deep.	[d] 3,998,844	1,377 682		
	do	Massapequa supply pond.	7 C.	1892	Surface				
567	do	Massapequa station.	8 C.	1896	53 4½-inch wells, 37 to 106 feet deep.	[d] 5,373,196	(e)		
81	New York City, department of water supply, gas, and electricity (Borough of Queens).	Long Island City, station No. 1.	2 C.	1874	7 6-inch wells, 70 feet deep; 1 open well, 47½ feet diameter by 30 feet deep.		682,800		
175	do	Long Island City, station No. 2.	3 D.	1886	28 4-inch wells, 45 feet deep; 1 16-foot well, 22 feet deep.		[f] 803,000		
99	do	Long Island City, station No. 3.	3 D.	1894	12 4-inch wells, 41 feet deep.		621,000		
231	do	Fresh Meadow Station (formerly College Point station).	4 C.	1874	Springs	2,500,000		970,783	
								622,700	

[a] Numbers correspond to those used in the detailed records in Chapter IV and in the index maps, Pls. xix, xxiv.
[b] See Pls. xix, xxiv.
[c] Streams are very short and spring fed, and differ very little from springs.
[d] Average daily yield for test of July–December, 1896.

systems on Long Island—Continued.

Delivery of water.	Reservoir or standpipe. Capacity.	Size.	Elevation of reservoir or standpipe.	Miles of mains.	Fire hydrants.	Authority.	Date.	No.[a]
	Gallons.	*Feet.*	*Feet.*					
Smiths Pond station	41,580,000		5.09 −.33			I. M. De Varona	1896	
Ridgewood aqueduct			5.09 −.33			L. B. Ward	1899	
do	9,046,000		13.68 9.57			I. M. De Varona	1896	
do						do		
do	26,900,000		12.21 8.42			do		
	1,000,000,000					do	1894	
Not used	373,000,000					do	1896	
To Ridgewood pumping station.						do	1894	
do						L. B. Ward	1899	
To Millburn pumping station.	11,100,000		4.0 1.4			I. M. De Varona	1896	
	18,830,000		7.7 3.77			do	1896	
Millburn aqueduct						L. B. Ward	1899	487
do						do	1899	489
do	11,428,000		8.5 4.17			I. M. De Varona	1899	
do						L. B. Ward	1899	491
do	15,030,000		9.7 4.87			I. M. De Varona	1896	
do	28,990,000		14.9 6.9			do	1896	
do						L. B. Ward	1899	493
do	19,000,000		5.0 3.5			I. M. De Varona	1896	
do						L. B. Ward	1899	567
Direct service								81
do				23.19		L. B. Ward	1899	175
do								99
Direct; overflowing to standpipe.	936,000	135 by 35				Sanborn Map Co.[g]	1902?	231
do			188.8	15.42		L. B. Ward	1899	

[e] Not running.
[f] Destroyed by boiler explosion in 1900 and not rebuilt.
[g] Insurance maps of the Borough of Queens, city of New York, vol. 5, 1903.

TABLE VIII.—*Waterworks*

No.[a]	Owner.	Description.	Coordinates[b]	Service began.	Source of supply.	Estimated capacity of station per day.	Average yield per day for year given in last column.		
							Wells.	Springs.	Streams[c]
						Gallons.	*Gallons.*	*Gallons.*	*Gallons.*
238	New York City, department of water supply, gas, and electricity (Borough of Queens).	Bayside station (formerly Flushing station).	4 D	1874	21 3-, 4-, and 6-inch wells, 40 feet deep.		980,000		
						3,000,000	1,206,584		
					Oakland Lake[d]	1,780,000		1,780,000	
239	.....do.....	Whitestone, No. 1	4 D	1892	17 4- and 6-inch wells, 55 to 75 feet deep.		181,000		
						1,000,000	196,551		
242	.....do.....	Whitestone No. 2 (reserve station).	4 D	1888	5 3- and 4-inch wells, 80 feet deep.				
4	Blythebourne Water Co.	Principal station	1 B	1892	1 open well 5 feet diameter by 90 feet deep; 1 open well, 20 feet diameter by 90 feet deep.		200,000		
21	.....do.....	Reserve station	2 B	1890	2 7-inch wells, 70 feet deep.				
					Brooklyn waterworks.		106,000		
18	H. C. Pfalzgraf estate.		2 B	1891	Single well				
22	Flatbush Waterworks Co.		2 B	1882	3 5-inch wells, 18 feet deep; in each of 12 open wells, 8 feet diameter by 26 feet deep; 19 5-inch wells, 55 feet deep.		2,155,400		
134	German American Improvement Co.		3 B	1892	3 6-inch wells, 60, 65, and 70 feet deep.	70,000	70,000		
					Island Water Supply Co.[h]		90,600		
142	Woodhaven Water Supply Co.	Pumping plant at works of Agate Nickel Steel Ware Co.	3 C	1894	10 4-inch and 6 6-inch wells, 80 to 150 feet deep.		548,000		
223	Montauk Water Co.	Dunton	4 C	1895	17 10-inch wells, 30 to 50 feet deep.		1,800,000		
213	Jamaica Water Supply Co.	Jamaica	4 C	1887	7 10-inch, 12 5-inch wells, 50 to 60 feet deep.		1,500,000		
213	.....do.....	.....do.....	4 C	1887	1 8-inch well, 57 feet deep; 1 10-inch well, 150 feet deep; 1 8-inch well, 50 feet deep; 5-inch wells.	7,000,000	2,275,000		
219A	Holliswood private high service.	Hollis	4 C		Jamaica Water Supply Co.	75,000			
158	Citizens Water Supply Co.	Station No. 1	3 C	1894	28 6-inch wells, 45 to 62 feet deep.		608,000		
162	.....do.....	Station No. 2	3 D	1897	78 4½-inch wells, 45 to 80 feet deep.		1,510,000		
225	.....do.....	Station No. 3	4 C	1899	31 6-inch wells, 45 to 90 feet deep.		2,067,700		
					56 6-inch wells, 45 to 90 feet deep.	3,500,000			
150	.....do.....	Station No 4	3 C	1900	16 6-inch wells	2,500,000			
151	.....do.....	Station No. 5	3 C	1901	13 4½ and 6 inch wells	2,000,000			
153	Woodside Water Co.	Station No. 1	3 C	1897	178 shallow driven wells.		Small.		
161	.....do.....	Station No. 2	3 D				Not used.		
178	.....do.....	Station No. 3	3 D				Not used.		

[a] Numbers correspond to those used in the detailed records in Chapter IV and in the index maps, Pls. xix, xxiv.
[b] See Pls. xix, xxiv.
[c] Streams are all very short and spring fed, and differ very little from springs.
[d] Also called Douglass Pond; used only for reserve in case of fire.
[e] Insurance maps of the Borough of Queens, city of New York, vol. 5, 1903.
[f] Five elevated tanks.
[g] In 1897, M. N. Baker.
[h] Now New Lots pumping station of the Brooklyn waterworks.

systems on Long Island—Continued.

Delivery of water.	Reservoir or standpipe.		Elevation of reservoir or standpipe.	Miles of mains.	Fire hydrants.	Authority.	Date.	No.[a]
	Capacity.	Size.						
	Gallons.	*Feet.*	*Feet.*					
Direct; overflowing to standpipe.			218	15.4		L. B. Ward	1899	
	762,000	135 by 33				Sanborn Map Co.[e]	1902?	238
						Chief engineer	1902	
Direct; overflowing to standpipe.				10.4		L. B. Ward	1899	239
....do	212,000	95 by 20	182.3			Sanborn Map Co.[e]	1902	
....do								242
Direct; overflowing to tanks.	[f] 125,000		160	30		L. B. Ward	1899	4
						I. M. De Varona	1896	21
						L. B. Ward	1899	
				1.7		....do	1899	18
Direct; overflowing to standpipe.	239,700	20 by 102	194	72	[g] 590	....do	1899	22
To standpipe and mains.								134
Direct service; overflowing to reservoir.	[h] 4,000,000 500,000		125	32	[j] 493	L. B. Ward	1899	142
Direct service; overflowing to standpipe.		2 standpipes.	175	9.5		....do	1899	223
....do		....do.[k]	175	[l] 60+		....do	1899	213
						C. A. Lockwood	1903	213
	511,000	40 by 50		62	640	Sanborn Map Co.[j]	1903	
			210	2		L. B. Ward	1899	219A
Direct	183,600	25 by 50[m]						158
....do				[n] 56.92		L. B. Ward	1899	162
....do								
						J. Edward Meyer, superintendent.	1903	225
						....do	1903	150
						....do	1903	151
Direct				7.5		L. B. Ward	1899	153 161 178

[a] Statement of F. H. Luce, superintendent.
[j] Insurance maps of the Borough of Queens, city of New York, vol. 4, 1903.
[k] Combined capacity about 1,000,000 gallons.
[l] In Greater New York.
[m] Manual of American Waterworks, 1897, p. 123.
[n] In 1899 delivered 2,336,400 gallons to the city for use in Long Island City.

TABLE III.—*Waterworks*

No.[a]	Owner.	Description.	Coordinates (b)	Service began.	Source of supply.	Estimated capacity of station per day.	Average yield per day for year given in last column.		
							Wells.	Springs.	Streams [c]
						Gallons.	*Gallons.*	*Gallons.*	*Gallons.*
174	Steinway & Son [d]		3 D		Wells				
176	Bowery Bay Building and Improvement Co.	North Beach	3 D		17 6-inch wells, 65 to 70 feet deep.		500,000		
273	Queens County Water Co.	Valley Stream	5 B	1884	16 3 and 4 inch wells, 145 to 180 feet deep; 45 3-inch wells 30 to 50 feet deep.		1,123,581		
					32 4 and 5 inch wells, 33 feet deep.	5,000,000	1,634,000		
					19 6-inch wells, 150 to 190 feet deep.				
379	Rockville Center village.	Rockville Center	6 B	1896	2 wells, 50 feet deep	500,000	25,000		
					4 8-inch wells, 40 to 50 feet deep.		150,466		
375	Long Beach Association.[f]	East Rockaway	6 B		Shallow wells				
397	Freeport village	Freeport	6 B	1894	2 6-inch wells, 35 feet deep; 2 10-inch wells, 35 feet deep.		60,000		
490	Merrick Water Co.	Merrick	7 B	1896	Shallow wells				
405	Hempstead village.	Hempstead	6 C	1890	Wells		200,000		
					8 6-inch wells, 50 feet deep.		75,000		
414	Garden City Water Supply Co.	Garden City	6 C	1876	Well 50 feet diameter by 35 feet deep.		500,000		
442	C. H. Mackay	Roslyn	6 D		Shallow wells				
452	Sea Cliff Water Co.	Sea Cliff	6 E	1872	6 6-inch wells, 60 feet deep.	500,000	33,000	(h)	
					4 6-inch wells				
466	Pratt estate	Glen Cove	6 E	1891	3 driven wells		75,000		
					3 6-inch wells, 38 to 48 feet deep.		100,000		
					1 6-inch well, 82 feet deep.				
455	Nassau County Water Co.	do	6 E	(j)	4 10-inch wells, 45 to 60 feet deep.	1,000,000+			
525	do	Oyster Bay	7 E	(k)	Driven wells				
503	do	Hicksville	7 D	(k)	2 8-inch wells, 85 feet deep.				
579	do	Farmingdale	8 C	(k)	Driven wells				
568	Amityville Water Works Co.	Amityville	8 C	1893	6-inch wells, 40 feet deep.	500,000	104,000		
674	Babylon Sumpwams Water Co.	Babylon	10 C	1893	Driven wells				
					4 8-inch wells, 60 feet deep.	1,000,000			
							175,000		
650	Huntington Water Works Co.	Huntington	8 E	1893	3 8-inch wells, 60 feet deep.	150,000			
							66,274		
658	Northport Water Works Co.	Northport	9 E	1893	2 8-inch wells, 47 feet deep.		96,280	(m)	
675	Great South Bay Water Co.	Bayshore	10 C	1889-90	20 5-inch wells, 40 to 45 feet deep.	2,250,000			

[a] Numbers correspond to those used in the detailed records in Chapter IV and in the index maps, Pls. xix, xxiv.
[b] See Pls. xix, xxiv.
[c] Streams are very short and spring fed, and differ very little from springs.
[d] A small private plant supplying houses in the vicinity of the Steinway piano factory.
[e] Two standpipes.
[f] Private plant supplying Long Beach.
[g] Manual of American Waterworks, 1897.

systems on Long Island—Continued.

Delivery of water.	Reservoir or standpipe.		Elevation of reservoir or standpipe.	Miles of mains.	Fire hydrants.	Authority.	Date.	No.[a]
	Capacity.	Size.						
	Gallons.	*Feet.*	*Feet.*					
To tank								174
Direct				1.5		L. C. L. Smith, consulting engineer.	1903	176
Direct and to standpipes.	(e)			37.17+		L. B. Ward	1899	273
	235,000	20 by 100		50	300	C. R. Bettes	1902	
	93,000	12 by 100						
Direct, overflowing to standpipe.	235,000	20 by 100		5	49	M. N. Baker	1897	379
						Village clerk	1902	
To standpipe at Long Beach.				4				375
Direct, overflowing to standpipe.						Engineer	1902	397
Pumped by windmill to tanks.								490
Direct pumping and to standpipe.	258,000	20 by 110		6	75	M. N. Baker[g]	1897	405
						Engineer	1903	
Direct pressure				11	35	M. N. Baker[g]	1897	414
To tanks				1				442
To standpipe	235,000	20 by 100				J. T. Pirie, president	1903	452
To reservoir and standpipe.[i]				8	30	Sanborn Map Co	1902	
To standpipe	158,000	30 by 30		5	9	M. N. Baker	1897	466
do			190			D. M. Munger superintendent.	1903	
			160					
do	282,000	20 by 120	265			W. F. Clapton, superintendent.	1903	455
			145					
do	235,000	20 by 100	245		49	Oscar Darling, consulting engineer.	1903	525
			145					
Acme system	25,000				49	do		503
do	25,000				50	do		579
To standpipe	300,000	20 by 125				Solomon Ketchem, secretary.	1902	568
Acme system	(l)			7	33	M. N. Baker	1897	674
do	100,000					Oscar Darling, consulting engineer.	1903	
				8	47	Chief engineer	1903	
To reservoir	250,000		170			Oscar Darling, consulting engineer.	1903	650
				10	47	J. Irwin, treasurer	1903	
Ground reservoir	250,000			5	33	Oscar Darling	1903	658
Acme system	25,000					S. L. Ackerly		
To standpipe	350,000	20 by 150				C. A. Lockwood, secretary.	1903	675
				16	140	Sanborn Map Co.[n]	1902	

[a] Originally supplied by springs.
[i] Reservoir, 120,000 gallons; elevation, 175 feet; standpipe, 235,000 gallons; elevation, 250 feet.
[j] Construction well advanced in September, 1903.
[k] Under construction September, 1903.
[l] Two 7,000-gallon tanks.
[m] The springs which formerly supplied this plant were abandoned in 1903.
[n] Maps of Bayshore and Islip.

TABLE III.—*Waterworks*

No.[a]	Owner.	Description.	Co-ordinates (*b*)	Service began.	Source of supply.	Estimated capacity of station per day.	Average yield per day for year given in last column.		
							Wells.	Springs.	Streams [c]
						Gallons.	*Gallons.*	*Gallons.*	*Gallons.*
777	Great South Bay Water Co.[d]	Patchogue	13 D	1887					
803	Port Jefferson Water Co.	Port Jefferson	11 F.	1898	2 6-inch wells, 54 feet deep.	200,000	80,000		
863	Riverhead Water Works.	Riverhead	18 E	1892	1 8-inch well, 225 feet deep; 1 6-inch well, 305 feet deep.[e]		6,000		
861	Quantuck Water Co.	Quogue	18 D.	[g] 1903	6 8-inch wells, 40 feet deep.	500,000			
879	Southampton Waterworks Co.	Southampton	21 E	1894	3 6-inch wells, 80 feet deep.	1,000,000	340,500		
910	Easthampton Home Water Co.	Easthampton	23 F.	1899	3 4-inch wells, 70 to 75 feet deep.	250,000	[f] 250,000		
903	Sag Harbor Water Co.	Sag Harbor	22 F.	1889	Ligonee Brook		(*j*)		150,000
889	Shelter Island Heights Association.	Shelter Island	21 H		Open well, 21 feet deep, with 6-inch pipe to a depth of 33 feet.	120,000	[f] 96,000		
890	Manhasset House.	....do	21 H		Group of 18 wells		(*l*)		
892	Greenport village.	Greenport	21 H	[m] 1889	9 6-inch wells, 28 to 48 feet deep.				

[a] Numbers correspond to those used in the detailed records in Chapter IV and in the index maps, Pls. xix, xxiv.
[b] See Pls. xix, xxiv.
[c] Streams are very short and spring fed, and differ very little from springs
[d] Until 1894 the Suffolk County Water Company.
[e] Statement of driller, N. W. Davis.
[f] Pumped by water power.
[g] June 1 1903.

systems on Long Island—Continued.

Delivery of water.	Reservoir or standpipe. Capacity.	Reservoir or standpipe. Size.	Elevation of reservoir or standpipe.	Miles of mains.	Fire hydrants.	Authority.	Date.	No.[a]
	Gallons.	*Feet.*	*Feet.*					
.....	272,000	20 by 115..	.....	18	98	Sanborn Map Co	1902	777
To standpipe.....	.....	.....	.....	3.5	35	W. T. Wheeler, secretary.	1902	803
To tank[f].....	.....	.....	.....	.....	.....	J. R. Perkins.....	1903	863
....do.....	40,000	.....	100±	.....	17	Sanborn Map Co.....	1902	
To standpipe.....	235,000	20 by 100..	120±	7½	50	H. Gardner, treasurer.	1903	861
Acme system.....	([h])	.....	.....	.....	89	Geo. Elliston, engineer.	1902	879
To standpipe.....	85,000	.....	.....	.....	47	B. H. Van Scoy, president.	1903	910
.....do.....	235,000	20 by 100..	140±	5	34	H. F. Cook, president.	1902	903
To reservoir and tanks...	[k] 400,000	.....	100	.....	.....	Wesley Smith, superintendent.	1903	889
.....	.....	.....	.....	.....	.....	W. H. Havens, chief engineer.	1903	890
To standpipe.....	235,000	20 by 100..	.....	.....	.....	.....	.....	892

[h] Three 10,000-gallon tanks.
[i] Yield in summer, 1903. Average for year much less.
[j] Well supply abandoned.
[k] Ground reservoir. There are also three storage tanks in this system.
[l] Not known.
[m] Built by Greenport Water Company. Purchased by village 1899.

CHAPTER III.

MEASUREMENTS OF THE RATE OF UNDERFLOW ON LONG ISLAND.

By CHARLES S. SLICHTER.

DISTRICT INVESTIGATED.

The following determinations of ground-water velocities were made along the south side of Long Island, between the villages of Freeport and Massapequa. These places are located about 6 miles apart on the Montauk division of the Long Island Railroad, which between these points runs nearly east and west about 1 mile north of the edge of the extensive salt marshes which border the Atlantic Ocean. (See fig. 37.)

Freeport is about 24 miles from Brooklyn Bridge, and Massapequa, 6 miles east of Freeport, is within 2 miles of the western line of Suffolk County.

Within the 6-mile stretch above mentioned the city of Brooklyn has 5 pumping stations, drawing water from extensive batteries of driven wells. The names of these stations, from the west, are: Agawam, Merrick, Matowa, Wantagh, and Massapequa. A brick conduit on the north side of the right of way of the Long Island Railroad receives the water from the pumping station and carries it by gravity to a pumping station at Millburn, just west of Freeport, where an additional lift sends it into the city of Brooklyn.

Within the 6 miles from Freeport to Massapequa the conduit crosses several small surface streams, four of which have been ponded and their waters gated into the conduit. These surface waters flow into the conduit the year round, the driven wells constituting an auxiliary supply for the summer months, the period of use extending usually from July to December, but varying with the rainfall and other climatic conditions.

The particular district under discussion was selected as the object of study because, first, the region seemed typical of conditions on the south side of the island, and second, because the ground water was substantially in normal condition, owing to the fact that the driven-well plants had not been operated since the previous December. The purpose of the work was to determine the principal facts concerning the underground drainage of the island, so that a preliminary basis might be established from which an estimate of the amount of ground waters available for municipal supply could be made.

The determination of ground-water velocities was made at certain selected stations or localities, following in general an east-west line. The stations were

restricted for the most part to the highways or other public lands, but this fact did not interfere materially with the selection of the best sites for the work. One set of stations was placed south of the railroad and just north of the line of wells of the driven-well stations, it being considered of importance to measure velocities in the immediate neighborhood of the pumping plants both before and after pumping had commenced. Other stations were located north of the railroad and conduit, out of range of any extensive influence of the pumping plants.

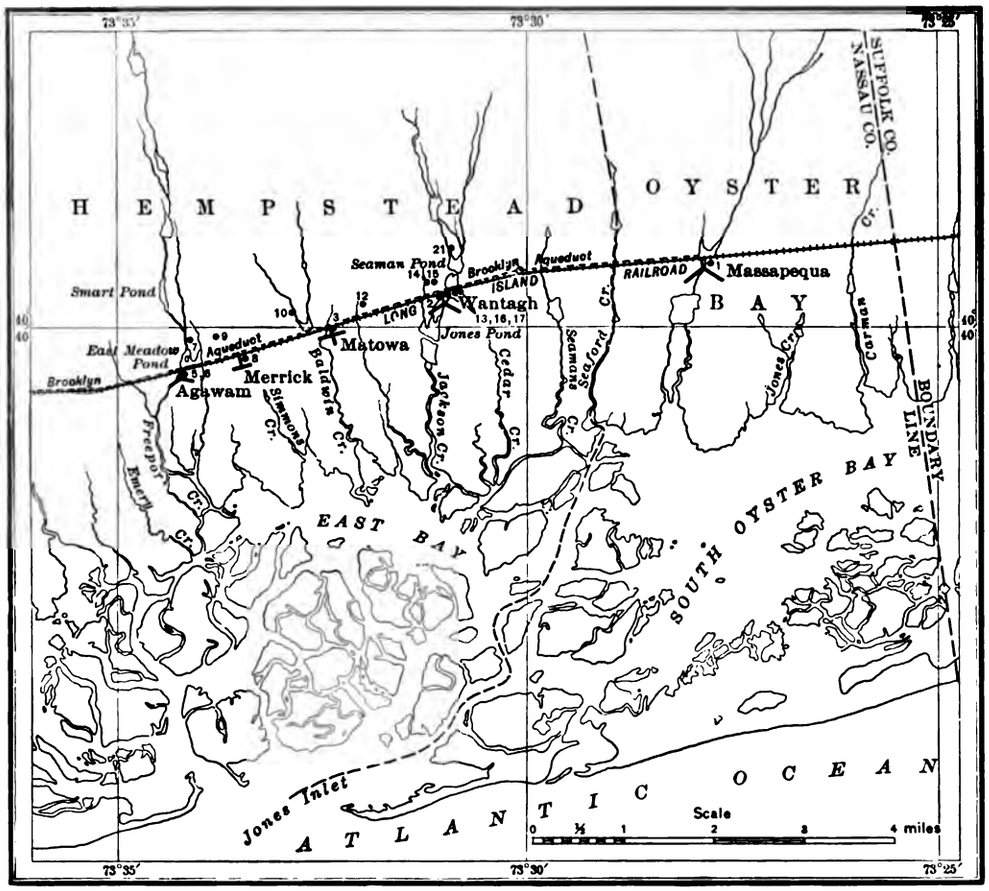


FIG. 37.—Map of southern Long Island, showing location of underflow stations at which determinations of the rate of flow of underground water were made.

Measurements were made by the electrical method described by the writer in Engineering News for February 20, 1902, and in Water-Supply and Irrigation Paper No. 67 of the United States Geological Survey.

The test wells were driven by the commission on additional water supply, and the measurements were in charge of the writer and of Mr. Henry C. Wolff.

APPARATUS USED.

The apparatus used comprised a series of test wells and various electrical devices for ascertaining the conditions that obtained in them.

TEST WELLS.

Test wells may be common 1¼-inch or 2-inch drive wells if the soil and water-bearing material is easily penetrated and if the depths desired to be reached do not exceed 30 or 40 feet; for greater depths and more difficult materials wells of heavier construction are necessary. The test wells put down by the commission on additional water supply for Greater New York in 1903 for the work described herewith are suitable for ordinary conditions as met with in the eastern part of the United States or in any place where the gravels are not too coarse or too compact. In them there was used full-weight standard wrought-iron 2-inch pipe

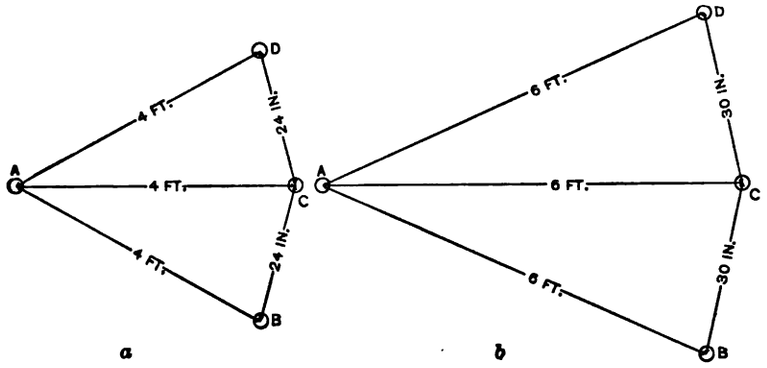


FIG. 38.—Plan of arrangement of test wells used in determining the velocity and direction of motion of ground waters. A, B, C, D are the test wells. The direction A C is the direction of probable motion of the ground waters. The dimensions given in plan (*a*) are suitable for depths up to about 25 or 30 feet; those in plan (*b*) for depths up to about 75 feet. For greater depths the distances A B, A C, A D, should be increased to 9 or 10 feet and the distances B C and C D to 4 feet. The well A is the "salt well" or well in which the electrolyte is placed.

in lengths of 6 or 7 feet, with long threads (1½-inch) and heavy wrought nipples which could be screwed up until the ends of the pipe abutted.

The well points were 4-foot standard brass jacket points, No. 60 gauze. For wells no deeper than 30 feet closed-end points were driven, but for deeper work open-end points were used. The test wells were driven in place by use of a ram from 150 to 250 pounds in weight, simultaneously hydraulicking a passage for the pipe with water jet in ¾-inch standard wash pipe. In fine material there were coupled ahead of the open-end well point 3 or 4 feet of pipe carrying a shoe coupling, so that the sand in running in through the open end of the pipe would not rise above the bottom of the screen inside of the finished well.

The test wells were grouped as shown in figure 38.

In case the wells are not driven deeper than 25 feet, an "upstream" or "salt" well, A, is located, and three other wells, B, C, and D, are driven at a distance of 4 feet from A, the distance between B and C and between C and D being about 2 feet. The well C is located so that the line from A to C will coincide with the

probable direction of the expected ground-water movement. This direction should coincide, of course, with the local slope of the water plane. For deeper work the wells should be located farther apart, as shown in the right portion of figure 38. For depths exceeding 75 feet, a radius of 8 or 9 feet and chords of 4 feet should be used, the general requirement being that the wells should be as close together as possible, so as to cut down to a minimum the time required for

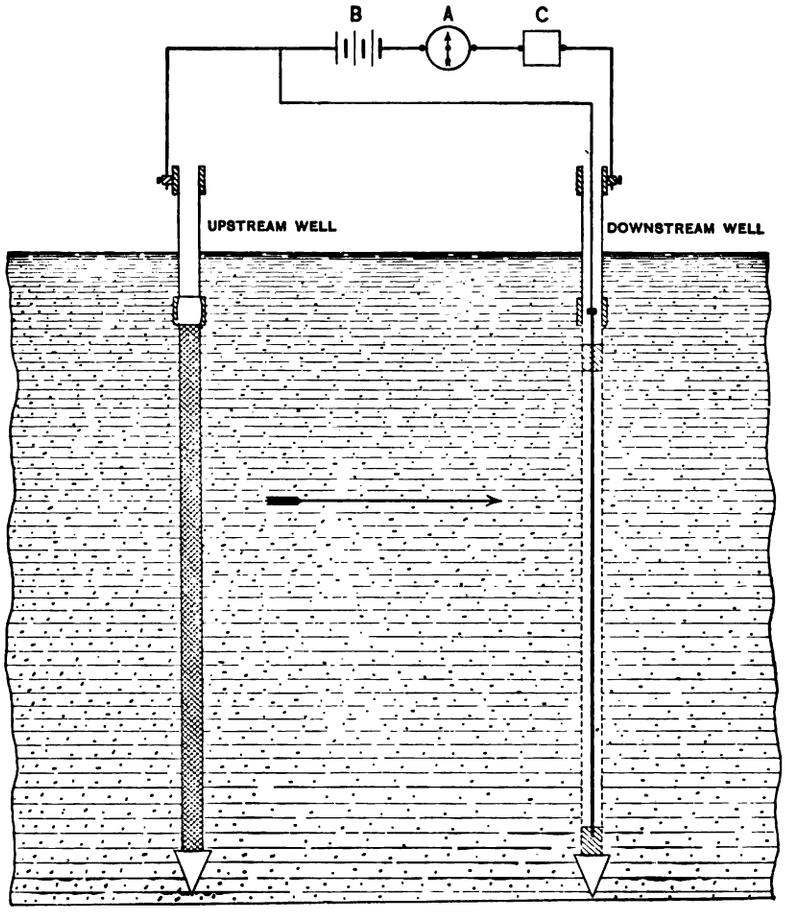


FIG. 39.—Diagram showing electrical method of determining the velocity of ground water. The ground water is supposed to be moving in the direction of the arrow. The upstream well is charged with an electrolyte. The gradual motion of the ground water toward the lower well and its final arrival at that well are registered by the ammeter A. B is the battery and C a commutator clock which is used when A is a recording ammeter

a single measurement, but not so close that important errors are liable to be introduced from the inability to drive the wells perfectly straight and plumb. On this account, the deeper the wells the farther apart they should be placed. The angles B A C and C A D should not exceed 30°.

Electrical connection is made with the casing of each test well by means of a drilled coupling carrying a binding post. Each of the downstream wells, B, C, D,

contains within the well point or screen section an electrode consisting of a nickeled brass rod three-eighths inch by 4 feet, insulated from the casing by wooden spools. This electrode communicates with the surface by means of a rubber-covered copper wire. Fig. 39 illustrates the arrangement of electric circuits between the upstream well and one of the downstream wells. An electrode is shown in Pl. XX Each of the downstream wells is connected to the upstream well in the manner shown in that plate.

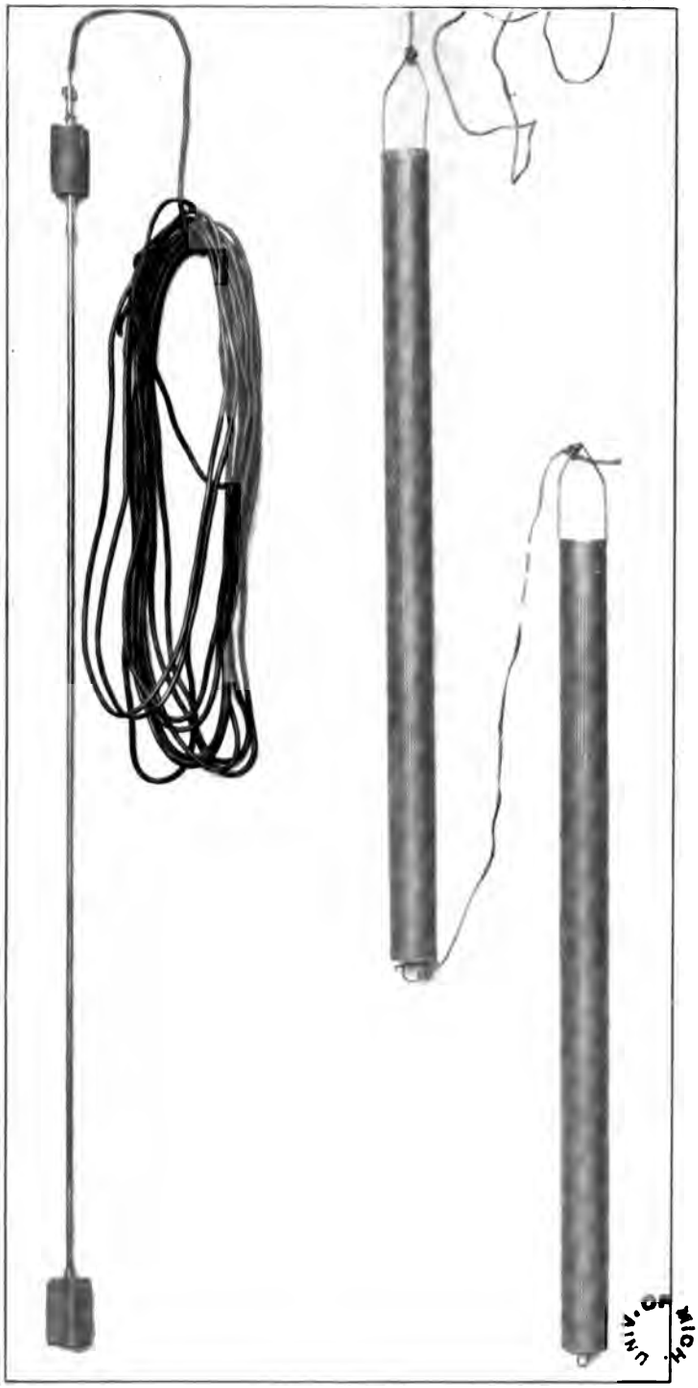
FORMS OF METERS.

The meters used were of two types: (1) Direct reading or hand, which required the personal presence of the operator every hour for reading, and (2) self-recording, which required attention but once a day.

DIRECT-READING METERS.

A photograph of the direct-reading underflow meter is shown in Pl. XXI, *A*. Six standard dry cells are contained in the bottom of the box, their poles being connected to the 6 switches shown at the rear of the case. By means of these switches any number of the 6 cells may be thrown into the circuit in series. One side of the circuit terminates in 8 press keys, shown at the left end of the box. The other side of the circuit passes through an ammeter shown in the center of the box, to 2 three-way switches at right end of the box. Four of the binding posts at the left end of the box are connected to the casing of well A, and to the three electrodes of wells B, C, and D, in order. The binding posts at the right end of the box are connected to the casings of wells B, C, and D. There are enough binding posts so that two different groups of wells can be connected to the same instrument. When the three-way switch occupies the position shown in photograph, pressing the first key at left end of box will cause the ammeter to show the amount of current between casing of well A and casing of well B. When the next key is pressed the ammeter will indicate the current between the casing of well B and the electrode contained within it. In one case the current is conducted between the two well casings by means of the ground water in the soil; in the second case by means of the water within well B. By putting the three-way switch in second position and pressing the first and the third keys in turn, similar readings can be had for the current between casings A and C, and between casing C and its internal electrode. Similarly with the switch in the third position readings are taken by pressing the first and the fourth keys. The results may be entered in a notebook, as shown in Table IX, p. 95.

The electrolyte does not appear at one of the downstream wells with very great abruptness, but its appearance there is somewhat gradual, as shown in the curves in figs. 40 and 41. The time required for the electrolyte to reach its maximum strength in one of the downstream wells (and, hence, for the current to reach its maximum value) may vary from a few minutes in a case of high ground-water velocity to several hours in a case of low velocity. The writer formerly supposed that the gradual appearance of the electrolyte at the downstream well was largely due to the diffusion of the dissolved salt, but it is now evident that diffusion plays but a small part in the result. The principal cause of the phenomenon is now



UNIV. OF MICH.

ELECTRODE AND PERFORATED BRASS BUCKETS USED IN CHARGING WELLS.

known to be the fact that the central thread of water in each capillary pore of the soil moves faster than the water at the walls of the capillary pore, just as the water near the central line of a river channel usually flows faster than the water near the banks. For this reason, if the water of a river suddenly be made muddy at a certain upstream point, the muddy character of the water at a downstream point will appear somewhat gradually, being first brought down by the rapidly

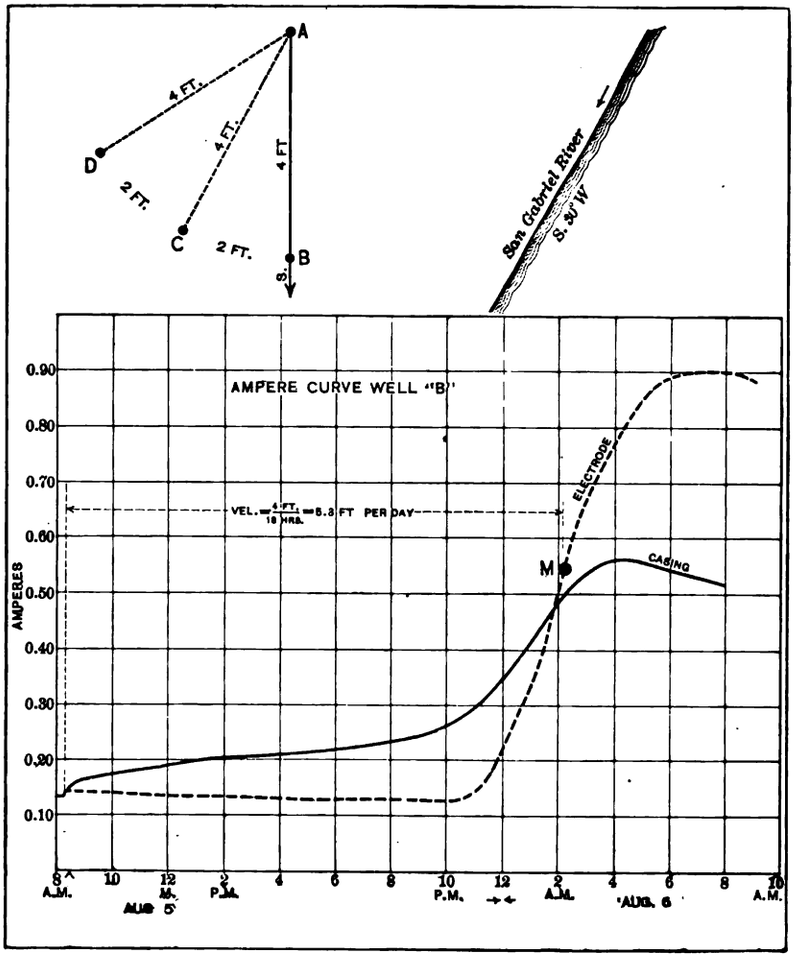


FIG. 40.—Curves showing electric current between casing of well A and casing of well B (heavy curves), and between casing of well B and its internal electrode (dotted curve) at station No. 5, San Gabriel River, California. These curves illustrate results made with the hand form of apparatus.

moving water in the center of the channel, and later by the more slowly moving water near the banks. The effect of the analogous gradual rise in the electrolyte in the downstream well requires us to select the "point of inflection" of the curve of electric current as the proper point to determine the true time at which the

arrival of the electrolyte should be counted. This point is designated by the letter "M" in figs. 40 and 41.

Owing to the repeated branching and subdivision of the capillary pores around the grains of the sand or gravel, the stream of electrolyte issuing from the well will gradually broaden as it passes downstream. The actual width of this charged water varies somewhat with the velocity of the ground water, but in no case is the rate of the divergence very great. Figures 42 and 43 show some actual determinations of the spread of the electrolyte around a well in a coarse sand, in one case the ground water moving 12 feet per day, and in the other case moving 23 feet per day. Samples of ground water were taken from small test wells placed only 6 inches apart, and the amount of salt or electrolyte was determined chem-

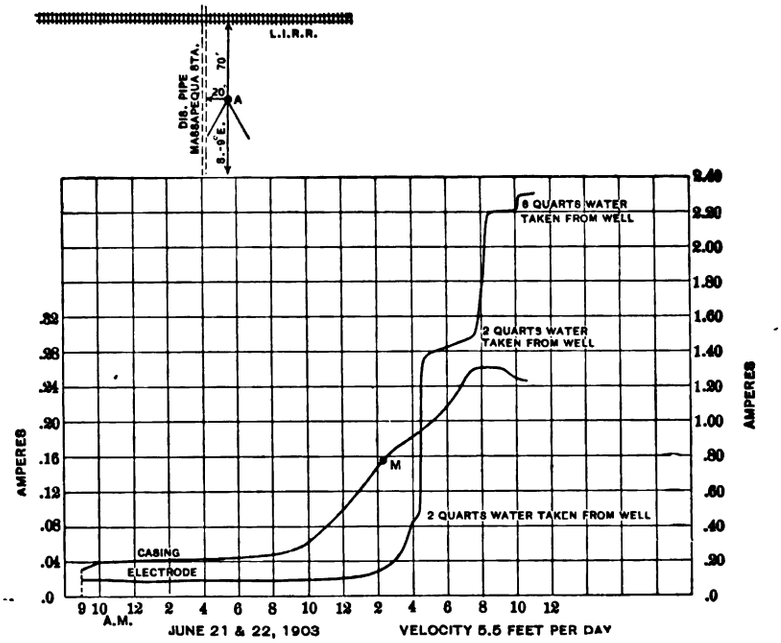


FIG. 41.—Curves showing possibility of using direct-reading apparatus when well points are not used. The casing in this instance consisted of common black 2-inch pipe, with a few small holes in bottom section. The "casing" curve must be relied upon for determining velocity. The "electrode" curve was obtained by drawing water from well C, as shown on diagram, the charged water penetrating the well through small holes and the open end of well.

This diagram shows the velocity and direction of flow of underground water at Massapequa, L. I., Station No. 1. Velocity 5.5 feet a day, S. 10° E.

ically. The amount at any point is indicated by the area of the circles shown in the diagrams. It will be seen that the salt barely showed itself at a distance of 3 inches upstream from the well. Three feet downstream from the well the width of the salt stream was about 3 feet in the first case and about 2 feet in the other case.

Application of principles.—It is possible to dispense with the circuits from the casing of well A to those of the other wells, as the short circuit between the well and the electrode forms the best possible indication of the arrival of the electrolyte at

A. UNDERFLOW METER, SHOWING CONNECTIONS WHEN USED AS DIRECT-READING APPARATUS.

B. COMMUTATOR CLOCK FOR USE WITH RECORDING AMMETER.

the downstream well. For cases in which the velocity of ground water is high the circuit to well A is practically of no value, but for slow motions this circuit shows a rising current before the arrival of the electrolyte at the lower well, often giving indications of much value to the observer.

The method can be used quite successfully even though nothing but common

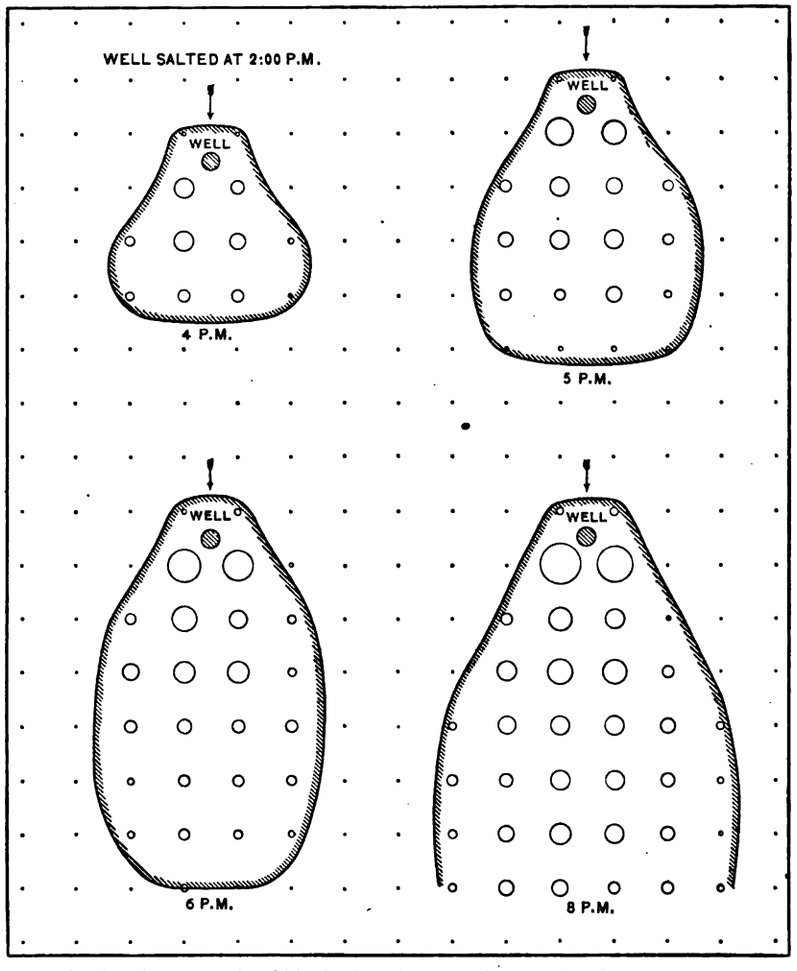


FIG. 42.—Diagram showing the manner in which the electrolyte spreads in passing downstream with the ground water. The shaded circle shows the location of the salted well, and samples were taken from the sand at the corners of 6-inch squares, shown by dots in the diagram. The areas of the circles are proportional to the strength of the electrolyte found at their centers. The rough outline indicates the area covered by the charged water at the times specified. The velocity of the ground water (in the direction of the arrows) was 12 feet a day. It can be seen that the electrolyte barely reached a distance of 3 inches against the direction of flow.

pipe be used for the wells. In this case, however, the absence of screen or perforations in the wells renders the internal electrodes useless, and one must depend upon the circuit from well casing of the upstream well to well casing of downstream well.

The results in the table on page 95 and fig. 41 present such a case. In this case the wells were not provided with well points, but merely possessed a 4-foot length of pipe, provided with 4 or 5 holes on opposite sides of the pipe containing small ½-inch washer screens. These few openings are not sufficient to permit the electrolyte to freely enter the well, so that readings between casings were relied

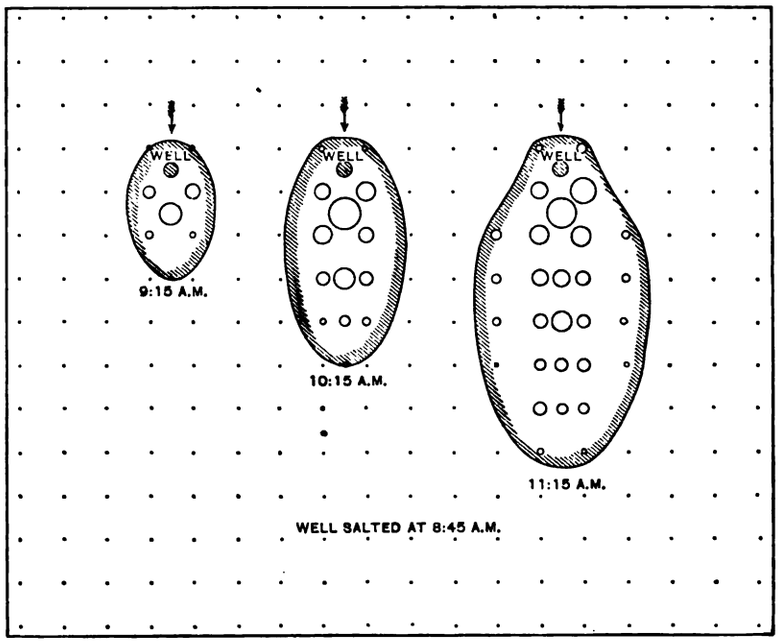


FIG. 43.—Diagram showing spread of electrolyte from a well with ground water moving about twice as fast as in fig. 42, or 22.9 feet a day. The electrolyte spreads less rapidly for the higher velocity, as is shown at a glance.

upon for results. As a matter of fact, enough of the electrolyte did get into the well to give small increased readings, but in order to secure the electrode readings given in the table, water was removed from the downstream wells by a small bucket holding about 6 ounces, so as to force a quantity of the water surrounding the well into the perforated sections.

TABLE IX.—*Station No. 1, Massapequa, Long Island, June 21 and 22, 1903.*

FIELD RECORD OF ELECTRIC CURRENT READINGS IN AMPERES, OBTAINED WITH DIRECT READING UNDERFLOW METER.

Time.	Casing B.	Electrode B.	Casing C.	Electrode C.	Casing D.	Electrode D.
June 21, a. m:						
8.45	0.03	0.08	0.03	0.10	0.03	0.09
9[a]						
9.30 [b]	.04	.08	.04	095	.036	.088
10	.04	.079	.039	.092	.036	.088
10.30	.04	.079	.04	.097	.039	.087
11	.04	.079	.04	.095	.059	.087
11.30	.04	.079	.04	.091	.039	.087
12	.041	.079	.04	.092	.040	.087
June 21, p. m:						
1	.042	.079	.04	.090	.040	.088
1.30	.042	.079	.04	.092	.040	.088
2	.043	.079	.04	.092	.040	.089
2.30	.043	.078	.041	.094	.040	.088
3 [b]	.043	.078	.041	.094	.040	.090
3.30	.043	.078	.040	.094	.041	.090
4	.043	.078	.042	.094	.041	.090
4.30	.043	.078	.042	.095	.041	.090
5	.043	.078	.042	.096	.041	.090
5.30	.045	.078	.043	.096	.041	.090
6.30	.045	.078	.043	.097	.042	.091
7	.045	.078	.046	.099	.041	.091
7.30 [b]	.045	.078	.046	.099	.041	.090
8	.045	.080	.048	.099	.042	.093
8.30	.049	.080	.049	.100	.043	.094
9	.048	.079	.050	.100	.043	.094
10.30	.050	.079	.070	.101	.045	.095
12	.050	.079	.095	.106	.047	.095

[a] 10 pounds of sal ammoniac placed in well A.

[b] 2 pounds of sal ammoniac placed in well A.

TABLE IX.—*Station No. 1, Massapequa, Long Island, June 21 and 22, 1903*—Continued.

FIELD RECORD OF ELECTRIC CURRENT READINGS IN AMPERES, OBTAINED WITH DIRECT READING UNDERFLOW METER—Continued.

Time.	Casing B.	Electrode B.	Casing C.	Electrode C.	Casing D.	Electrode D.
June 22, a. m:						
1	0.051	0.079	0.120	0.122	0.049	0.099
2	.051	.079	.147	.152	.050	.100
3 [a]	.050	.079	.168	.195	.050	.100
4	.053	.079	.178	.430	.050	.100
4.30	.053	.079	.188	.470	.050	.100
4.40				[b] 1.3		
5	.053	.075	.200	1.4	.050	.100
6			.200	1.4		
7.45			.260	1.5		
8	.052	.075	.260	[c] 1.9	.050	[c] .100
8.15				[c] 2.20		
8.30				[c] 2.20		
9.15			.26	2.20	.049	.099
10	.050	.072		2.20	.049	.099
10			.25	[d] 2.30		
11			.245	2.30		
11				[d] 2.30		

[a] 2 pounds of sal ammoniac placed in well A.
[b] Before this reading some water was taken from well C.
[c] About 2 quarts of water were taken from well C before this reading.
[d] After 6 quarts of water were taken from well C.

In cases where good well points are used the ground water charged with the electrolyte finds its way gradually and naturally into the well. The well point should be clean enough to allow as free passage into the well as through the soil itself. Second-hand points used for this purpose may show a marked lag in the entry of the electrolyte. By comparing the curves for station No. 1 (fig. 41) with those of stations No. 6 (fig. 46) and No. 21 (fig. 57), where good well points were used, the lag caused by insufficient perforations in the well of station No. 1 is brought out very clearly.

Granulated sal ammoniac is used in well A, a single charge varying from 4 to 10 pounds. If common pipe without points or screens is used for the wells, so that internal electrodes must be dispensed with, about 2 pounds should be used every hour. The dry salt should not be poured directly into the well, but should be lowered in perforated buckets, shown in Pl. XX. These buckets are $1\frac{3}{4}$ by 30 inches and hold about 2 pounds of the salt. Two of these buckets may be tied one above the other for the initial change, followed by two more in ten or twenty minutes.

If the wells are not too deep, the sal ammoniac may be introduced into the well in the form of a solution. A common bucketful of saturated solution is suffi-

cient. There is an uncertainty in introducing the sal ammoniac in solution in deep wells, as the time required for the solution to sink to the bottom of the well may be considerable.

The ammeter used in the work has two scales, one reading from 0 to 1.5 amperes and the other from 0 to 5 amperes. With a given number of cells, the amount of current between the upstream and downstream wells will depend, of course, upon several factors, such as the depth of the wells and their distance apart, but more especially upon the amount of dissolved mineral matter in the ground water. The initial strength of the current can be readily adjusted, however, after the wells have been connected with the instruments, by turning on or off some of the battery cells by means of the switches at the rear of the box. A good rule is to use enough cells to make the initial current, if practicable, about one-tenth of an ampere.

SELF-RECORDING METER.

In the second form of underflow meter, self-recording instruments are used so as to do away with the tedious work of taking the frequent observations day and night, required when direct-reading instruments are used. The arrangement of the apparatus is not materially different from that described above. In the place of the direct-reading ammeter a special recording ammeter is used, of range 0 to 2 amperes. It has been found practicable, although a matter of no small difficulty, to construct an instrument of this low range sufficiently portable for field use and not too delicate for the purpose for which it is intended. The ammeter has a resistance of about 1.6 ohms and is provided with an oil dash pot to dampen swing of arm carrying the recording pen. The instruments were manufactured by the Bristol Company; they have gone through hard usage in the field without breakage or mishap. The portability of the instruments will be materially increased by changes in design which are now being made.

The methods of wiring the wells when the recording instruments are used is slightly changed. In this case one side of the battery circuit is connected to casing of well A and to all of the electrodes of wells B, C, and D. The other side of the battery is run through the recording ammeter to a commutator clock, which, once every hour, makes a contact and completes the circuits, one after the other, to a series of binding posts. One of these binding posts is connected to the casing of well B, one to the casing of well C, and one to the casing of well D. The time of contact is ten seconds, which gives the pen abundant time to reach its proper position and to properly ink its record.

Pls. XXI, *B*, and XXII, *A*, show two commutator clocks made for this purpose by the instrument maker of the college of engineering, University of Wisconsin. The clock movement is a standard movement of fair grade, costing about $5. It can readily be taken from the case for cleaning or oiling and as quickly replaced. A seven-day marine movement with powerful springs is best for this purpose.

It will be seen from the method of wiring the wells that the record will show the sum of the current between well A and well B added to the current between

the casing of well B and its electrode. The removal of the connection to well A would permit the record to show the current between the casing of a downstream well and its electrode, but the connection to the upstream well involves no additional trouble and occasionally its indications are of much service, especially if the velocities are low.

All of the instruments above mentioned can be placed in a common box, 16 by 22 by 36 inches, covered with tar paper and locked up. Pl. XXII, *B*, shows a photograph of the instruments thus arranged. The shelf contains the recording ammeter (shown at left of cut) and the commutator clock (shown at right of cut).

The contacts of the commutator clock are arranged about five minutes apart, so that the record made for the wells will appear on the chart as a group of lines, one for each downstream well, of length corresponding to the strength of the current. The increasing current corresponding to one of the wells will finally be indicated by the lengthening of the record lines for that well. This can be seen by consulting the photographs of records shown in Pl. XXIII. Light-green ink is used for record charts and red ink in the recording pen, so that record lines can be distinguished when superimposed upon the lines of the chart. A special chart has been designed for this work, and is furnished by the Bristol Company as Chart 458.

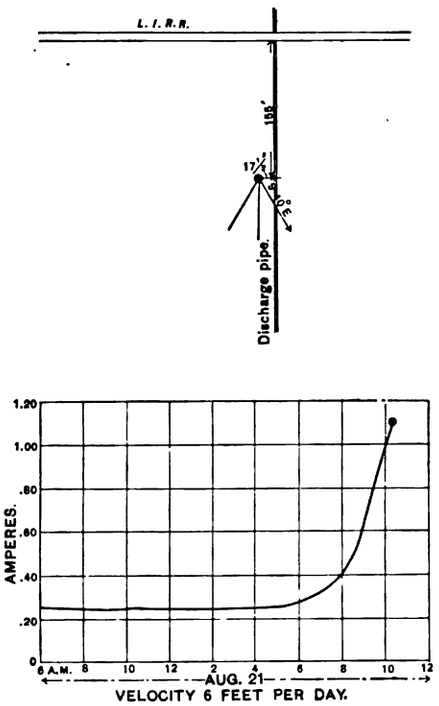


FIG. 44.—Diagram showing velocity and direction of flow of underground water at Wantagh pumping station.

The recording instruments in use have given perfect satisfaction, and the method is a great improvement in accuracy and convenience over the direct-reading method. The highest as well as the lowest ground-water velocities yet found have been successfully measured by the recording instruments. By using one or two additional dry cells the instrument is quite as sensitive as the direct-reading type.

In using the recording instruments but a single charge of salt need be placed in the upstream well. If the wells are deep it is important to use enough salt solution to be sure that the salt reaches as far down as the screen of the well point immediately after the solution is poured into the well. A gallon of solution will fill about 6 feet of 2-inch wrought-iron pipe, so that 10 gallons of solution should be used if well is 60 feet deep. If the proper amount of solution be not used it will take an appreciable time for the solution to reach the bottom of the well by convection currents and the results will be vitiated to that extent. As before stated, it is preferable to introduce into the well granulated sal ammoniac contained in a suitable bucket, in case the depth of the well renders the use of a solution uncertain.

A. COMMUTATOR CLOCK FOR USE WITH RECORDING AMMETER.

B. RECORDING AMMETER, COMMUTATOR CLOCK, AND BATTERY BOX IN USE IN THE FIELD.

PRINCIPLES INVOLVED.

The principles involved in the working of the apparatus are quite simple. The upstream well A is charged with a strong electrolyte, such as sal ammoniac, which passes downstream with the moving ground water, rendering the ground water a good electrolytic conductor of electricity. If the ground water moves in the direction of one of the lower wells, B, C, D, etc., the electric current between A and B, A and C, or A and D will gradually rise, mounting rapidly when the

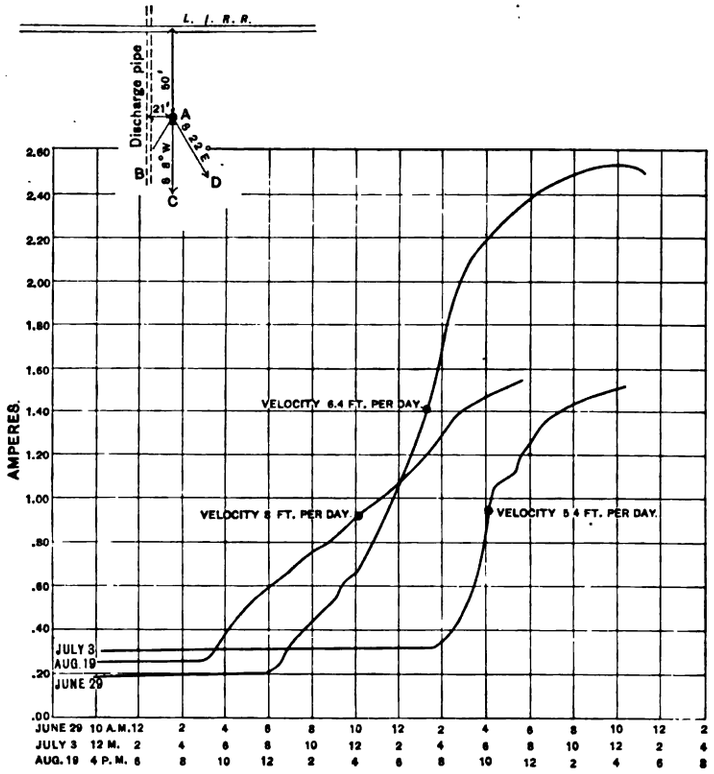


FIG. 45.—Diagram showing velocity and direction of flow of underground water at Agawam pumping station (Station 5).

electrolyte begins to touch one of the lower wells. When the electrolyte finally reaches and enters one of the wells B, C, D, it forms a short circuit between the casing of the well and the internal electrode, causing an abrupt rise in the electric current. The result can be easily understood by consulting fig. 40, in which the current is depicted graphically.

The time which elapses from the charging of the well A, to the arrival of the electrolyte at the lower well, gives the time necessary for the ground water to cover the distance between these two wells. Hence, if the distance between the wells be divided by this elapsed time, the result will be the velocity of the ground water.

RESULTS AND CONCLUSIONS.

EXISTENCE OF UNDERFLOW.

The 6-mile line from Freeport to Massapequa is, as has been stated, about 1 mile distant from the edge of the tidal marshes bordering the Atlantic Ocean. North of this line for a distance of 9 or 10 miles the natural surface drainage of the land is toward the south, the slope for nearly 8 miles of the distance being almost exactly 15 feet to the mile. This drainage plain is not only very flat and unbroken, but the surface conditions are exceedingly favorable for the absorption of a large percentage of the rainfall. The soil for the most part is coarse and sandy and

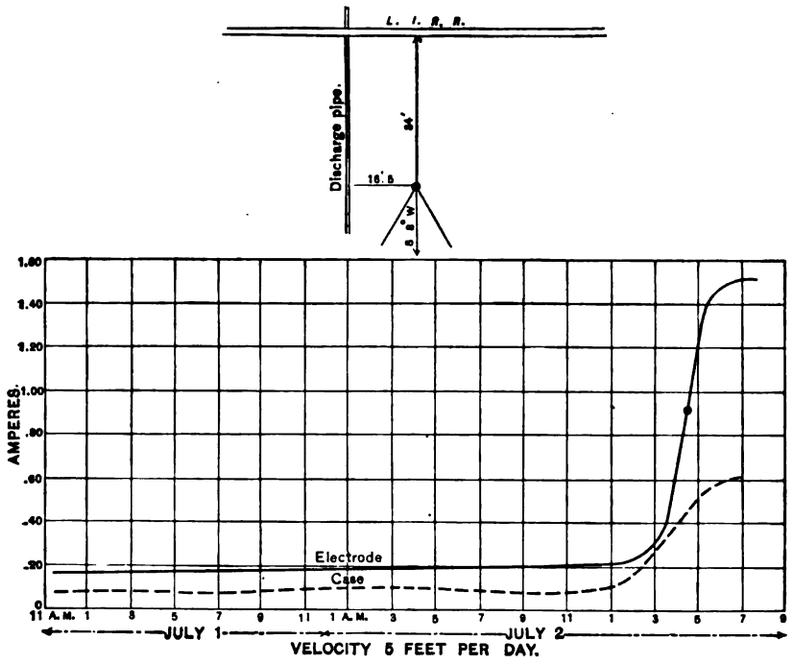
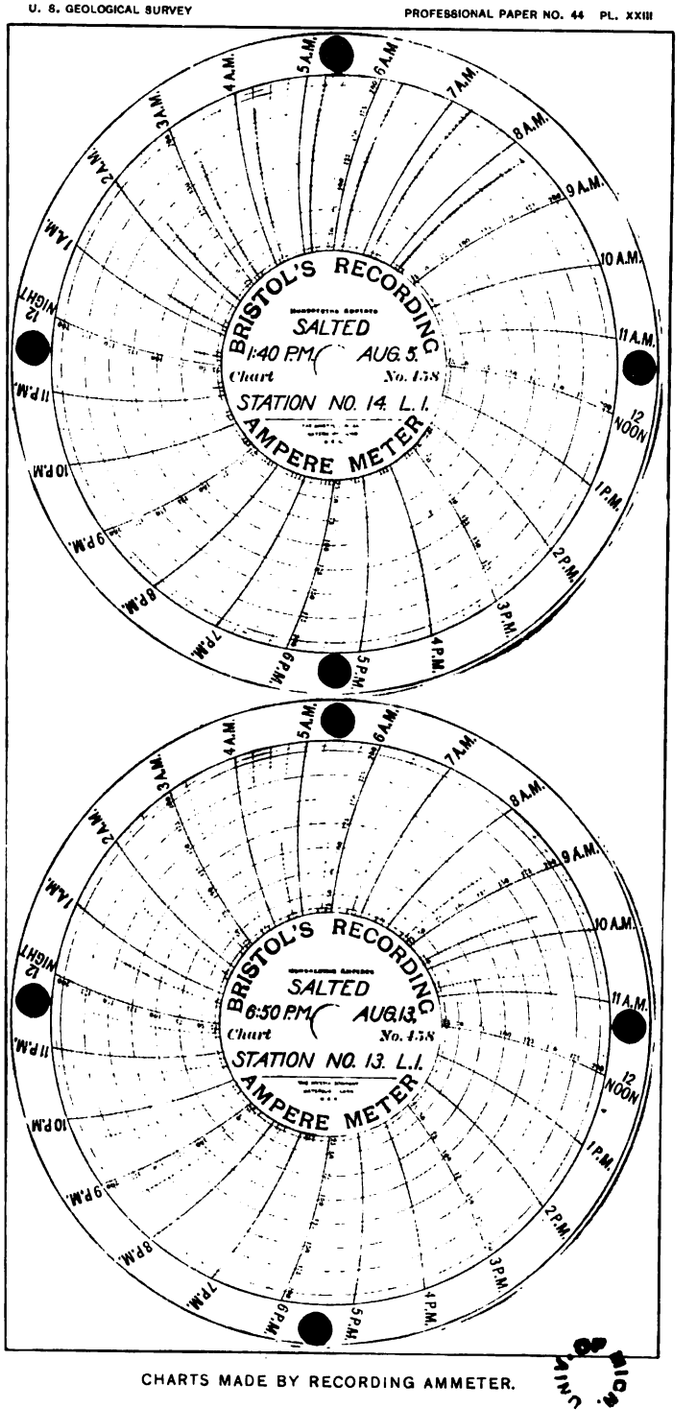


FIG. 46.—Diagram showing velocity and direction of flow of underground water at Agawam pumping station (Station 6).

very porous. The slope of the water plane is somewhat less than that of the surface of the land, being approximately 10 or 12 feet to the mile. The underground drainage is in general toward the south, the main east-west underground watershed probably coinciding within a mile or two with the surface watershed. The average rainfall is about 44 inches, a very large share of which enters the ground.

In the localities where the test wells were bored the material for the first 30 to 40 feet was yellow sand and gravel, quite clean and uniform, but growing finer with the depth. The first 20 feet below the water plane seemed in every case to be of high transmission capacity, and the material below this level was usually of increasing fineness, finally changing into a fine, dark-colored, micaceous sand. At a depth of from 40 to 60 feet a compact layer of clayey and bog-like material was



CHARTS MADE BY RECORDING AMMETER.

often met with, and in driving the test wells into and through this layer the water rose continuously in the wells until a marked artesian head was developed. Immediately below this compact layer good sands were again encountered.

In the report on New York's water supply made by John R. Freeman in the year 1900 it is stated as probable that the layer of clayey material referred to above is distributed as a wide and practically unbroken sheet 40 to 60 feet beneath the surface of the south-sloping drainage plain of the island.

One of the objects of the measurement of ground-water velocities was to determine whether or not there was a considerable southerly movement to this water in the sands and gravels above the supposed clay sheet and to determine the order of magnitude of such a movement if it existed. Whenever there

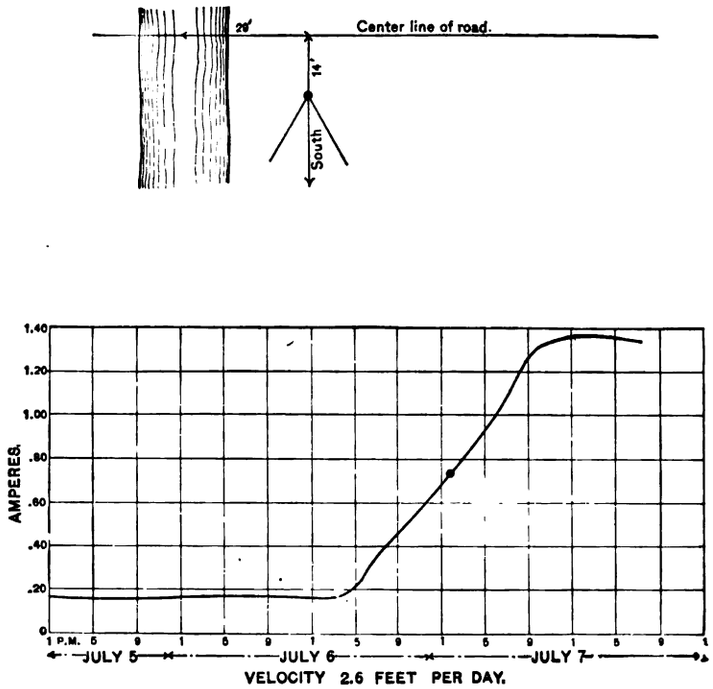


FIG. 47.—Diagram showing direction and velocity of flow of underground water at East Meadow Brook and Babylon road (Station 7).

exists in any drainage area a body of ground water which does not escape into the beds of surface streams as seepage water but continues seaward through the sands and gravels independent of the surface streams, this moving sheet of water is known as the underflow. One of the problems was, therefore, to determine whether or not a true underflow existed in this part of Long Island, and to learn something of its magnitude if it was found to exist. Another problem was to discover, if practicable, if any part of the underground drainage existed below the bed of clay; in other words, it was sought to determine whether the underground drainage consisted only of a surface zone of flow, or whether a deeper zone of flow—or possibly several deeper zones—were also present.

In respect to the first problem above mentioned—the existence of an underflow—there can be no question but that a true underflow of considerable importance exists within a depth below the surface of from 40 to 50 feet. In practically all of the stations established a good movement was found to exist, having a strong southerly component, in many cases surprisingly free from the influence of neighboring surface streams. The velocity near the surface—from 16 to 24 feet below the water plane—ran as high as 5 to 12 feet per day. At greater depths the velocities ran much less; at two stations, at depths of 30 and 42 feet, the velocities were each about 15 inches per day. At station No. 9 the sand was so fine at a depth of 45 feet

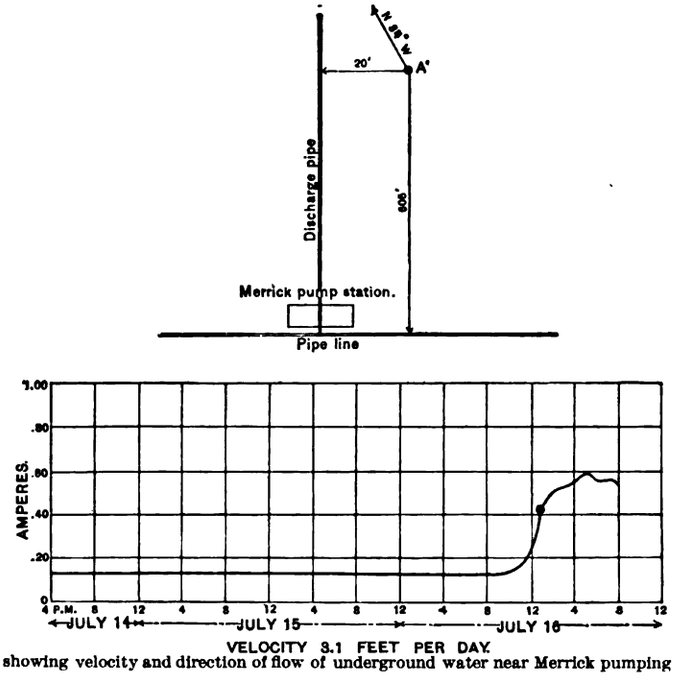


FIG. 48.—Diagram showing velocity and direction of flow of underground water near Merrick pumping station (Station 8).

that it could not be prevented from running into the bottom of the well above the top of the screen so that the wells could not be used.

The existence of a deep zone of flow was also established. At station No. 15 clay was encountered at a depth of about 44 feet. These wells were driven to a depth of about 62 feet, when an artesian head of about 30 inches developed. A measurement was then made, the screens on the wells being just below the impervious layer. A velocity of 6 feet per day was found to exist, in a direction about 10° west of south. The rate of flow at the same point just above the clay was only 18 inches per day, so that a true deep zone of flow undoubtedly exists at this point. This result, although very important, was not a surprise, as it had already been quite well established by the work of Mr. A. C. Veatch, of the United States Geological Survey, and others, that the clay layer, formerly supposed to be of

wide expanse and quite unbroken, is, as a matter of fact, absent over considerable areas of the island, so that no reason exists why a part of the underground drainage should not exist below this impervious bed.

The surface zone of flow of the underground waters is probably divided into a number of drainage areas, although it is exceedingly doubtful if the underground drainage basins coincide very closely with the drainage areas of the surface streams. In general, the velocities seemed to increase from west to east, the lowest velocities, however, being in a middle area, where the yellow gravels contain a quantity of

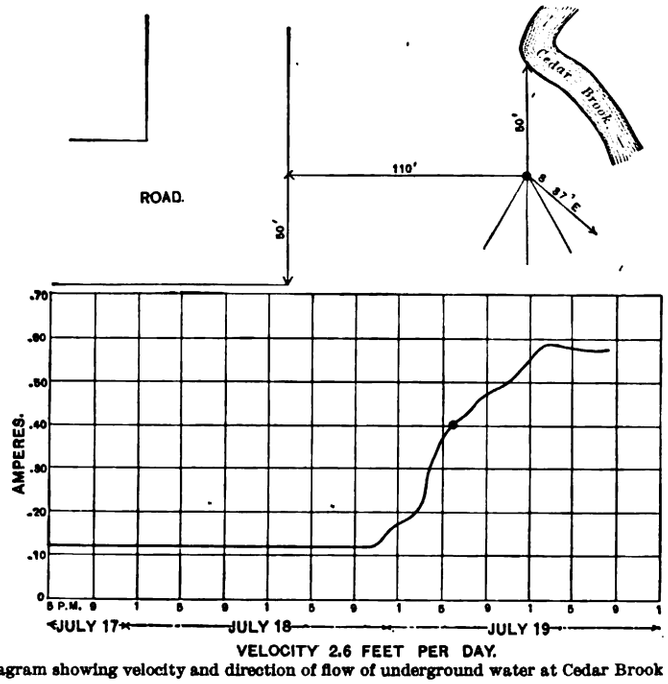


FIG. 49.—Diagram showing velocity and direction of flow of underground water at Cedar Brook (Station 10).

fine, clay-like silt. The Wantagh area seemed to have the largest underflow. It would be exceedingly interesting to have series of measurements extended eastward into Suffolk County. By increasing somewhat the number of stations in the area already covered and comparing with results from drainage areas in Suffolk County, a comparative study of underground drainage systems would result which ought to have much value in planning new sources of supply for Brooklyn.

The details of the measurements are given in the reports on individual stations contained in the following table. The locations of the stations are shown in fig. 37 (p. 87), and the curves of electrical current for various stations are given in fig. 41 and figs. 44 to 57.

TABLE X.—*Underflow measurements on Long Island.*

Number of station.	Velocity of ground water per day.	Direction.	Date, 1903.	Depth of wells below water plane.	Kind of point.
	Feet.			*Feet.*	
1	5.5	S. 10° E.	June 21	22	Perforated pipe.
2	2.0		June 24	22	Do.
2x	6.0	S. 40° E.	August 21	22	Do.
3	2.0		June 26	22	Do.
4	<2.0		June 27	22	Do.
5	6.4	S. 8° W.	June 29	22	Common point.
5x	5.4	S. 8° W.	July 3, 4	22	Do.
5y	8.0	S. 22° E.	August 19	22	Do.
6	5.0	S. 8° W.	July 1, 2	34	Do.
7	2.6	S.	July 5, 6	20	Do.
8	.0	S.	July 9, 11, 11	21.6	Open-end point.
8′	3.1	N. 34° W.	July 14, 15, 16, 17	21.6	Do.
10	2.6	S. 37° E.	July 17, 18, 19, 20	28.0	Common point.
11	.0		July 27–August 8	22.0	Do.
12	1.07	S. 3° E.	July 27–August 1	27.0	Open-end point.
13	96.00	S.	August 3, 4	16.0	Common point.
13	6.90	S.	August 3, 4	16.0	Do.
14	9.30	S.	August 5, 8	17.0	Do.
15	1.53	S.	August 6, 7, 8, 9, 10	42.0	Open-end point.
15x	6.00	S. 15° W.	August 17, 18, 19	62.5	Do.
16	.00	S. 30° E.	August 10, 11	16.0	Common point.
16x	77.00	S. 60° E.	August 13, 14	16.0	Do.
16x	11.60	S. 60° E.	August 13, 14	16.0	Do.
17	10.60	S. 30° W.	August 12, 13	20.0	Do.
18	<1.00	S.	August 15–21	62.0	Open-end point.
21	21.30	S. 50° E.	August 18, 19	16.5	Common point.
22	5.60	S. 30° E.	August 20, 21	16.0	Do

EFFECT OF THE RAINFALL ON RATE OF MOTION OF GROUND WATER.

An excellent opportunity was presented at one of the stations for noting the influence of a heavy rain upon the velocity of ground waters.

At station No. 5, at Agawam pumping station (see figs. 45 and 58), the upstream well A was salted at 9.45 a. m., June 27, 1903. Between 9 a. m. and 1 p. m. nearly 3 inches of rain fell, so that the heavy precipitation coincided with the early part of the ground-water measurements. The velocity found was 6.4 feet per day. On July 3 the experiment was repeated, there being no rain in the intervening time. The velocity found in the second trial was 5.4 feet per day. The change in velocity was undoubtedly due to the enormous rainfall during the first experiment. Part of the high velocity during the rainstorm may be attrib-

uted to the effect of the low barometer accompanying the storm, but part of it should be assigned to the increased head of ground-water pressure caused by the heavy rainfall upon the receiving area. As I have shown in another place,[a] ground waters move very much as electricity is conducted in a good conductor, the most striking quality in ground-water motion being an almost complete absence of true inertia. The motion of a mass of ground water, even for the highest velocities, is so slow that the resistance presented by the inertia of the ground water to an accelerating force is almost nothing when compared with the component of the retarding force, consisting of the capillary resistance in the small pores of the sand

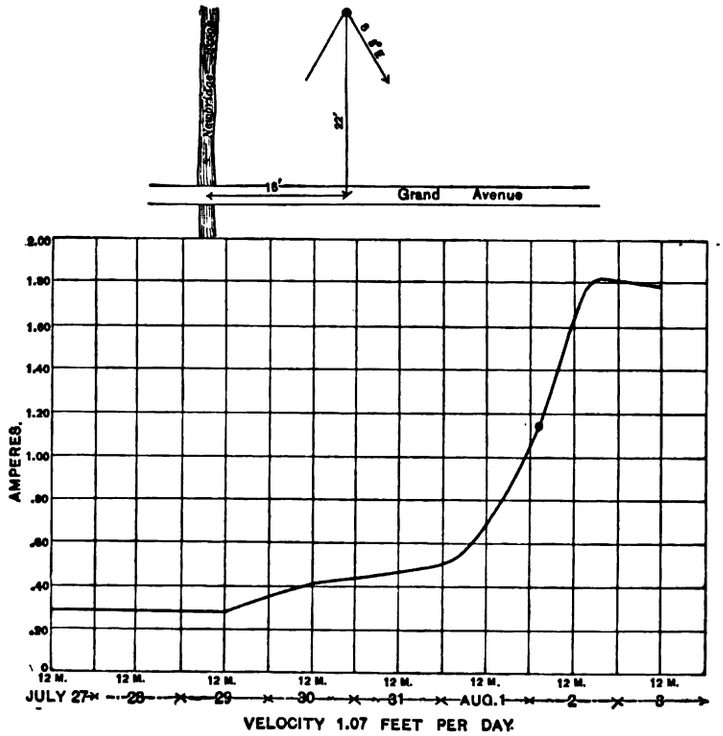


FIG. 50.—Diagram showing velocity and direction of flow of underground water at Grand avenue and Newbridge Brook (station 12).

or gravel. Actual computation will show that in a uniform sand of diameter of grain of one-half millimeter the ground water will reach within 1 per cent of its final maximum velocity by a sudden application of pressure or head in approximately thirty seconds of time. This surprising result of the theory of ground-water motions receives a very striking verification in the increase in velocity noted during the rain storm as described above.

These results have important bearings on our knowledge of ground-water phenomena in the neighborhood of a well. They indicate that the velocity of the

[a] Slichter, C. S., Theoretical investigation of motion of ground waters: Nineteenth Ann. Rept. U. S. Geol. Survey, pt. 2, 1899, p. 331.

ground waters in the neighborhood of a well reaches a maximum value soon after pumping is commenced. The gradual formation of the cone of depression near the well shows that there must be a progressive augmentation to the initial velocity of the ground waters toward the well. Nevertheless, the rate of depression of the water table is so slow that the ground-water motion established soon after the pumping has begun is substantially the same as after prolonged pumping. These remarks have their most important bearing upon the phenomena of the mutual interference of wells. The interference of one well with the supply of a neighboring well is thus seen to come into existence almost instantaneously and need not wait for the establishment of a cone of depression of large area. The phenomena of the cone of depression have much to do with the permanent supply of the well, but have slight bearing upon the proper spacing of the wells or the percentage of interference of one well with another.

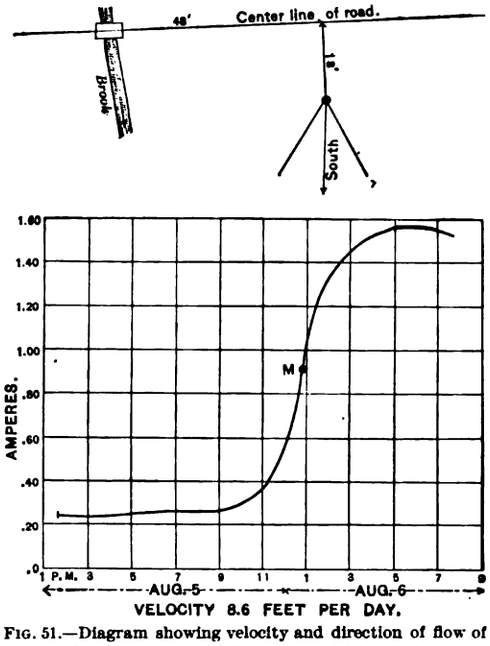


FIG. 51.—Diagram showing velocity and direction of flow of underground water at Bellevue road (station 14).

EFFECT OF SEEPAGE WATERS FROM PONDS AND RESERVOIRS ON RATE OF MOTION OF GROUND WATER.

Some unusually good opportunities occurred during the work on Long Island of determining the rate of seepage below the impounding dams of some of the storage ponds which the Brooklyn waterworks has established north of the conduit line referred to in the opening pages of this chapter. The batteries of driven wells which have been placed a few hundred feet south of nearly all of these ponds were quiescent during the summer of 1903, as the heavy rains furnished a sufficient quantity of surface water, and the auxiliary supply from the wells was not drawn upon, as usual, during July and August. At station No. 5, below East Meadow Pond and somewhat within its line of seepage (see fig. 58), the normal velocity of the ground water is 5.4 feet per day. At station No. 7, just north of the pond, the velocity was 2.6 feet per day. It seems clear that the natural velocity at these points, if the influence of the dam and pond were removed, would be about 4 feet per day. The velocity at station No. 6, located but a few feet from No. 5, at a depth of 34 feet, was 5 feet per day, as compared with 5.4 feet per day at a depth of 22 feet. The dam has the effect of making the water table nearly level in the immediate neighborhood of the pond, and also of greatly augmenting the slope of the water table for a short distance below the pond. The lower velocity above the pond and the higher velocity below the pond correspond with these facts. When there was no flow over the waste weir of the dam I measured the flow of the small

stream which rises below the dam at the bridge marked "A" in fig. 58. On July 10 this flow was 1.2 second-feet, practically all of which represented seepage water from the reservoir.

This amount, 1.2 second-feet, or 103,680 cubic feet per day, represents the amount of water that would flow through a bed of sand 30 feet deep and 1,000 feet wide at a velocity of 1 foot per day, the porosity of the sand being supposed equal to one-third. The normal velocity of the ground water is augmented, as shown by the measurement quoted above, by somewhat more than 1 foot per day. The width of the lower end of the pond, or the length of the earthen dam, is about 1,400 feet; basing the estimate on this minimum length and on a minimum depth of 30 feet, and augmented velocity of 1 foot per day, gives a minimum esti-

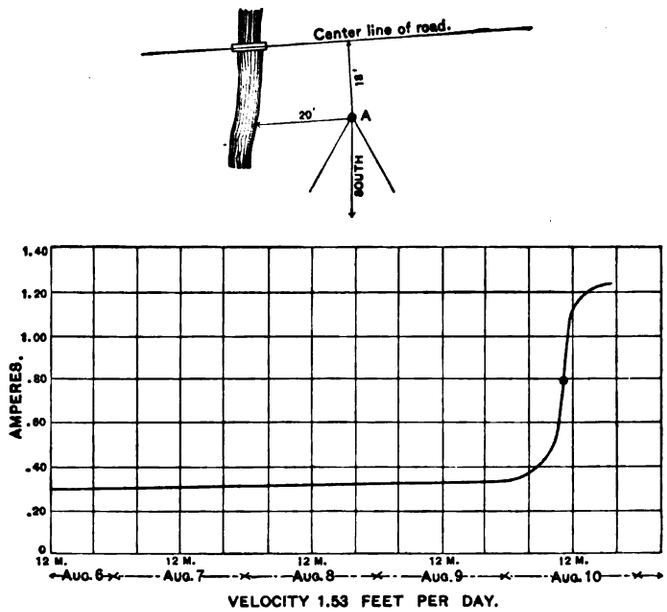


FIG. 52.—Diagram showing velocity and direction of flow of underground water at Bellevue road (station 15).

mate of the seepage from the dam of 1.6 second-feet; since 1.2 feet are known to actually come to the surface to feed the stream below the dam, it is evident that this estimate of seepage is a minimum. It seems evident that a considerable volume of seepage water could be recovered, without seriously lowering the water plane, by extending the line of driven wells to the east of the present terminus a distance of 600 or 700 feet.

A test well was driven in the lower south end of East Meadow Pond to a depth of 10 feet to determine the pressure gradient of ground water beneath the surface of the pond. The water in this test well stood about 1 foot lower than the water in the pond itself, showing a slope of the water plane, or a hydraulic gradient, of 7 feet to a mile. These facts are shown in fig. 59 (p. 113).

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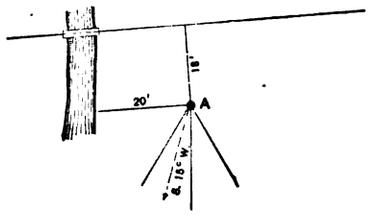
The gradient of the water plane below the dam—that is, between the dam and station No. 5—was 17 feet to the mile, so that the velocities to be compared are:

Pressure gradients and velocities above and below East Meadow Pond, Long Island.

Station.	Gradient of water plane per mile.	Velocity of ground water per day.
	Feet.	*Feet.*
No. 7, above pond	7	2.6
No. 5, below pond	17	5.4

These results check very favorably, especially when it is considered that the gradient above or north of station No. 7 was probably 10 or 12 feet per mile, which



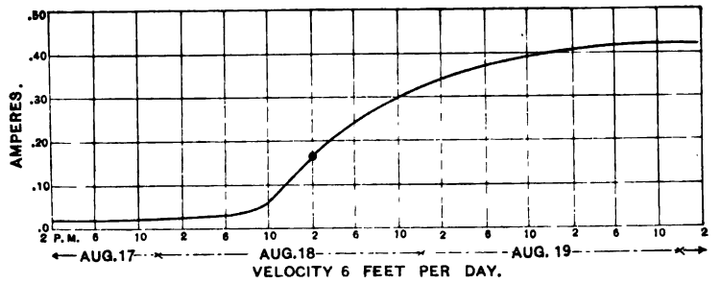


FIG. 53.—Diagram showing velocity and direction of flow of underground water at Bellevue road (station 15x).

would make the effective gradient at this station somewhat greater than 7 feet per mile.

Very striking results were obtained below the dam at the Wantagh Pond, where measurements were undertaken especially to determine the rate of seepage. The dam of the Wantagh Pond runs parallel to the right of way of the Long Island Railroad about 75 feet north of the latter, and has an extreme length of 500 or 600 feet. About 150 feet south of the railroad, downstream from the reservoir, the city of Brooklyn began in the summer of 1903 the construction of an infiltration gallery, consisting of a line of 36-inch double-strength tile laid at a depth of 16 feet below the water plane. It is purposed to extend this gallery for a mile east and west from the Wantagh pumping station. Stations Nos. 13, 16, and 17 were

established for the purpose of measuring the normal ground-water velocities at the depth (16 feet) of the purposed gallery. Two of these stations are immediately south of the pond and in the apparent direct line of seepage, while station No. 17 is located slightly to the east of the edge of the pond, and, as seems evident from fig. 60, just on the edge of the main influence of seepage from the ponds. The seepage velocities at stations No. 13 and 16 turned out to be enormous, the velocity at No. 13 being 96 feet per day, S., while at station No. 16 it was 77 feet per day, about S. 30° E., the deflection being toward the neighboring stream as shown in fig. 60. These velocities are the highest the writer has determined, and may be regarded as record-making rates for the horizontal motion of ground waters. Both measurements were made with the recording instruments; by consulting the curves in figs. 54, 55, and 56 it will be noted that each curve has two maximum points, which must correspond to the velocities in two distinct layers of gravel. The secondary velocity for station No. 13 was 7.4 feet per day and for station No. 16, 11.3 feet per day. A very striking verification of the fact that the high movements here found were due to the escape of water from the pond will be noted when the temperatures of the waters in the wells of these stations are compared with the temperatures of the water in the pond and the water in wells outside of the influence of seepage from the pond. Practically all water from wells on Long Island has a temperature between 58° and 60° F. In the present case, the temperature of water drawn from H. A. Russell's well, 22 feet deep, located just west of the Wantagh Pond (see fig. 60), was 59° F. on August 8, 1903, while the temperature of water from well D, of station No. 17, just east and slightly below the pond, was 61.2° F. on August 11, 1903. This well was 20 feet deep, the bottom being at the same depth as the wells of stations Nos. 13 and 16. The temperature of water in the pond varies more or less, especially the temperature of the surface layer. The temperature of the pond water on August 8, a cloudy day, was 72.5° F., and on July 30, a sunny day, 80° F. The temperature of water from the wells of station No. 13 was 65.8° F. on July 30, and that from the wells of station No. 16 on August 8 was 69.5° F. These high temperatures at stations Nos. 13 and 16 show that a large portion of the moving ground water must come directly from the pond, and

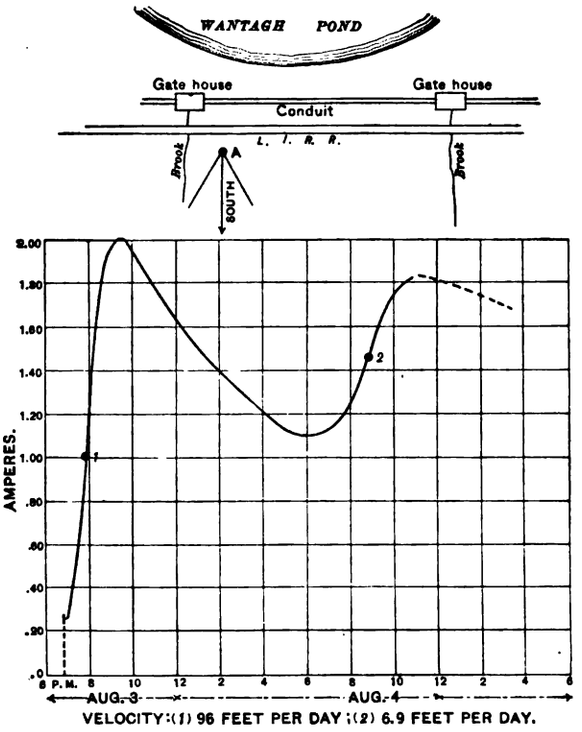


FIG. 54.—Diagram showing velocity and direction of flow of underground water south of Wantagh Pond at station 13.

that the rate of motion is so great that the ground water has not time to be reduced to the normal temperature of the ground.

At station No. 17 the water had a velocity of 10.6 feet per day in a direction S. 30° W., and a temperature of 61.5° F. The ground water at this point is probably not entirely free from the seepage water from the pond. The direction of flow, the velocity, and the temperature of the water all indicate, however, that a considerable part of the water is the natural underflow which at this point is diverted toward the lowland occupied by the streams below the pond.

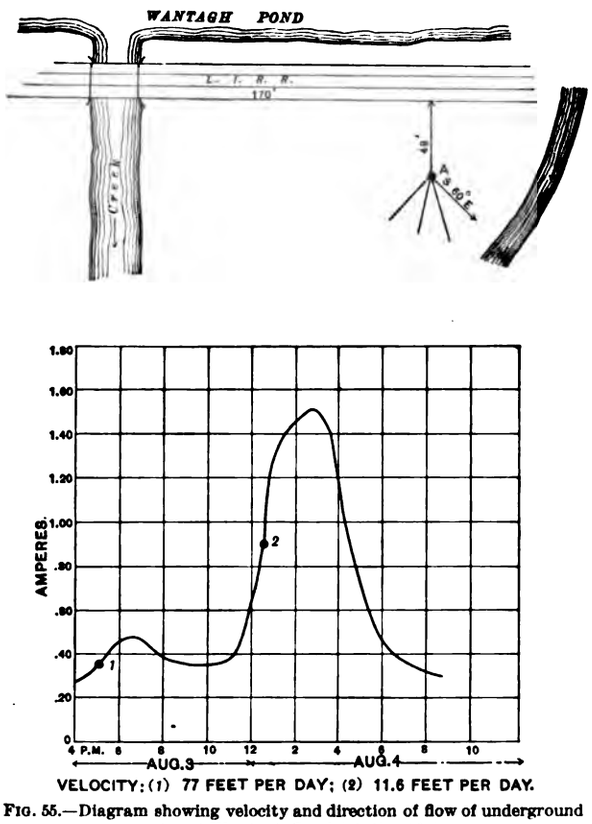


FIG. 55.—Diagram showing velocity and direction of flow of underground water at Wantagh Pond (station 16x)

There can be no doubt but that the proposed infiltration gallery will intercept a large amount of seepage water from the pond which at present runs entirely to waste. The amount of seepage in the first 16 feet of depth is probably somewhat less than 3 second-feet per 1,000 feet of length of cross section, or about 2 million gallons per twenty-four hours.

At station No. 21, located just above the Wantagh Pond, the velocity at a depth of 17 feet was 21.3 feet per day in a direction 60° east of south. This station is near the west bank of the main brook that feeds the pond, and the greater share of the ground water at this point percolates into the bed of the stream. The true underflow at this point can be found by taking the southerly component of this velocity, which gives 10.6 feet per day. The temperature of the ground water at this point was 58° F.

The increase of underflow rate at the Wantagh Pond from 10.6 feet per day to 96 and 77 feet per day, as compared with velocities above and below East Meadow Pond of 2.6 and 5.3 feet per day, respectively, are easily understood when the material constituting the bottom of the ponds is inspected. The material of the bed of the pond at Agawam is good, the soil being fine and compact, while at Wantagh the bottom of the pond is very sandy, in some places having a closer resemblance to a filter bed than to a puddled floor.

EFFECT OF PUMPING ON RATE OF MOTION OF GROUND WATER.

Through the courtesy of Mr. I. M. De Varona, an excellent opportunity was furnished the writer of making some observations upon the influence of pumping upon the normal rate of motion of ground water in the neighborhood of some of the Brooklyn driven-well stations. For this special purpose, the pumping stations at Agawam and Wantagh, which had been idle since December, 1902, were started up for two days each in August, 1902. Agawam was operated continuously from 7 a. m., August 19, to 7 a. m., August 21, and Wantagh was operated from 7 a. m., August 22, to 7 a. m., August 24. At the Agawam station observations were made at station No. 5, by means of the recording instrument. Well A was charged at 4 p. m., August 19, or after nine hours of continuous pumping, an interval supposed to be sufficient for the establishment of the maximum rate of flow of the ground water, although, of course, the cone of depression near the wells would still be changing quite rapidly.

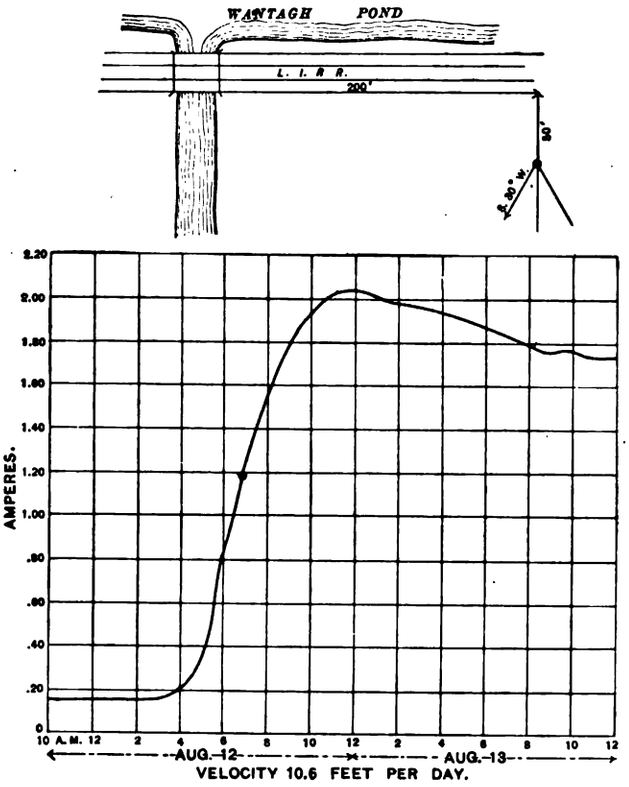


FIG. 56.—Diagram showing velocity and direction of flow of underground water at Wantagh Pond (station 17).

Station No. 5 is 30 feet north of the intersection of the chief suction mains communicating with the line of driven wells and 12 feet east of the central discharge main (see fig. 58). The depth of the test wells was 22 feet, while the depth of the 30 supply wells of the Agawam station system varies from 30 to 105 feet, the wells being arranged at intervals of 50 feet along two suction mains, each 750 feet long.

The rate of pumping during the 48-hour test was very uniform, this average being 2,250,000 gallons per twenty-four hours. The vacuum at the pump was maintained at 24 inches, while that at the first well east of the engine house was 23.2 inches. The charge of the centrifugal pump was dropped from 4 p. m. to 4.40 p. m. August 19, during which time the vacuum fell to 7 inches. This was the only interruption during the test.

The velocity determined at station No. 5 during the test was 8 feet per day, in a direction S. 22° E. The normal velocity at this station is 5.4 feet per day, S. 8° W., so that the influence of the pumping was to increase the velocity by 2.6 feet per day, or an increase of about 50 per cent. The actual velocity found and the percentage of increase are both very moderate, and indicate that the pumping station is not making an unreasonable draft upon the ground-water supply at this point.

The 30 wells of the Agawam supply station have screens each 10 feet long, or altogether about 730 square feet of screen. The maximum velocity of ground water as it enters these screens must be at the rate of 1,230 feet per day, since the actual pumpage was 2,250,000 gallons or 300,000 cubic feet per twenty-four hours. The mean velocity in the area, 10 by 1,500 feet cross section, immediately drawn upon by the wells (the supply wells covering an expanse of about 1,500 feet) was about 30 feet per day. The reduction of this rate to 2.6 feet per day represents a ratio of reduction of 11 to 1, which could be taken care of by a depth of 110 feet in the water-bearing gravels, without going outside of the 1,500-foot east and west line of the driven wells.

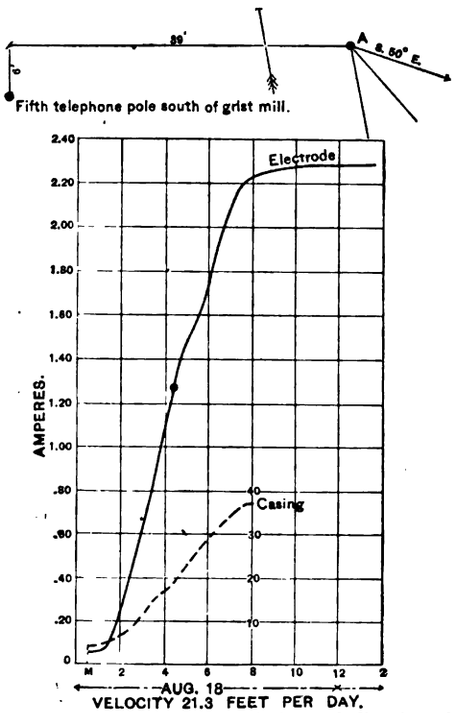


FIG. 57.—Diagram showing velocity and direction of flow of underground water above Wantagh Pond at station 21.

To put this in another way: The daily pumpage of 300,000 cubic feet of water could be supplied by the normal rate of motion of the ground water at this point (5.4 feet per day) through a cross section of 510,000 square feet, or, say, 100 feet deep by 1 mile wide. To supply this amount of water, if removed from the ground on each of the 365 days in a year, would require 1 foot of rainfall on 12 square miles of catchment area, or 18 inches of rainfall on 8 square miles of catchment area. Since the watershed is at least 12 miles north of the station, there is ample area to supply this amount of ground water, and the rate of removal at the Agawam station must, therefore, be regarded as moderate.

The observations at Wantagh pumping station were made on August 21 and 22. The pumping at this station began at 7 a. m., August 21, and continued forty-eight hours at the uniform rate of 4,366,000 gallons per twenty-four hours. The water at this station is drawn from 48 driven wells, arranged on three lines of suction mains, as shown in fig. 60. The east-west expanse of the two chief lines of wells is about 1,500 feet. The wells of this station are of two different types—shallow wells of depth of about 24 feet; and deeper wells, extending below an impervious bed to depths of from 60 to 112 feet. These latter wells have an artesian

head of 3 or 4 feet, and when the pumping plant is idle the water from the deep wells flows into the suction main and into the shallow wells, from the latter of which it escapes into the sands and gravels of the upper zone of flow, raising abnormally the zone of saturation.

An attempt was made on June 24 to measure the rate of motion of the ground water at station No. 2, situated 17 feet west of the chief discharge pipe, and 300 feet north of the intersection of the main suction pipes from the driven wells, as shown in fig. 60. The attempted measurement was a failure, it not being known

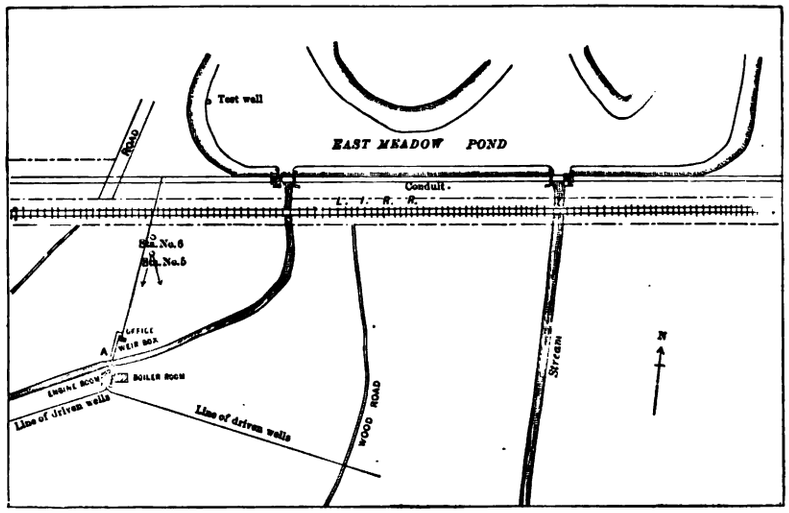


FIG. 58.—Map showing locations of stations 5 and 6 with reference to Agawam pumping station and East Meadow Pond.

at the time that the discharge from the numerous artesian wells was entering the surface layers of gravels and hence interfering with the normal flow in these gravels. The ground water at station No. 7 was, on account of this situation, either entirely stationary or moving slightly toward the north. On August 21, well A, of station No. 2, was charged at 6 p. m., after eleven hours of continuous

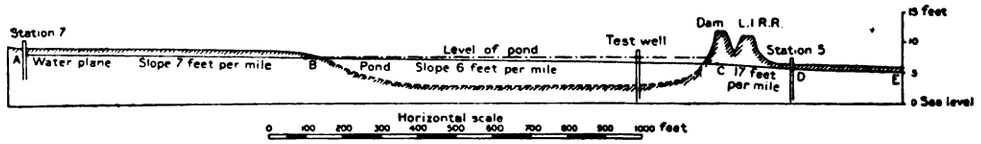


FIG. 59.—Vertical sections through stations 5 and 7 and test wells in Agawam Pond, shown in fig. 58

pumping from the driven wells. The velocity of the ground water observed was at the rate of 6 feet per day in a direction S. 10° E. As this station is distant only 300 feet from the lines of driven wells, it is evident that the withdrawal of 4,366,000 gallons or 582,000 cubic feet per twenty-four hours has not an excessive influence on the normal rate of motion of the ground water. The results at Wantagh compare very well with the results at Agawam and indicate that the driven-well plants have not exhausted the possibilities of ground-water developments.

SPECIFIC CAPACITY.

The writer uses the term "specific capacity" to designate the numerical expression of the readiness with which a well furnishes water to the pump.[a] This quantity can be obtained by dividing the yield of a well by the amount that the water is lowered in the well. Thus, in the case of the Agawam wells, the discharge was 1,560 gallons per minute under a vacuum of 23.2 inches of mercury at the first well east of the engine house. This vacuum corresponds to a head of 26 feet of water, but the water in the wells was lowered only 20 feet by the pump. The specific capacity of the group of wells was therefore 78 gallons per minute. The area of all strainer surface in the wells was 730 square feet. From these data it can be readily estimated that the specific capacity of the Agawam wells was 0.11

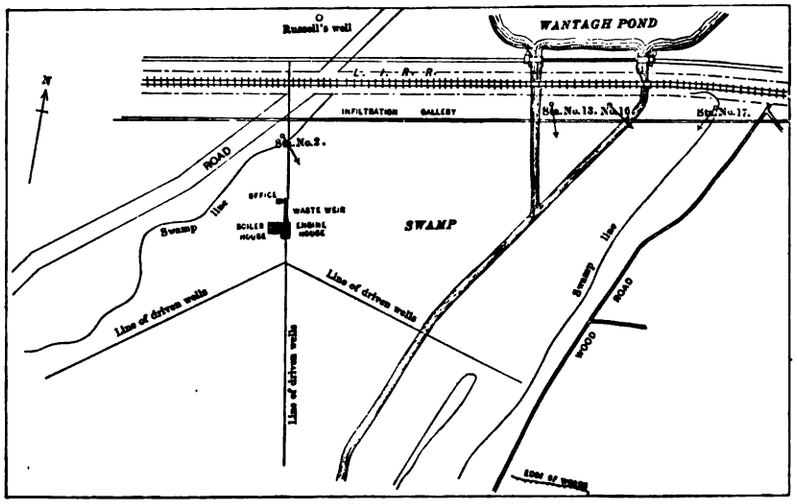


FIG. 60.--Map showing locations of stations 2, 13, 16, and 17, near Wantagh pumping station and Wantagh Pond.

gallon per square foot of well strainer under 1 foot head. This is a numerical expression of the degree of coarseness of the material in which the well is placed, combined, of course, with any resistance offered to the intake of water by the well strainer itself. At Wantagh station the discharge of 3,030 gallons per minute took place under a vacuum of 15.3 inches of mercury at the wells. The average head under which the water entered the wells was equivalent to 17.4 feet of water, from which the specific capacity is estimated to be 176 gallons per minute. The total strainer surface on the wells of this group amounts to 1,170 square feet, from which we conclude that the specific capacity per square foot of well strainer is 0.15 gallon per minute. This is nearly 40 per cent higher than at the Agawam wells. With carefully constructed wells of large diameter a minimum specific capacity of 0.15 gallon per minute per square foot of strainer can be depended upon for all wells in the Long Island watershed if properly designed strainers be used.

[a] See Water-Sup. and Irr. Paper No. 140, U. S. Geol. Survey, 1905, chapter 7.

CONCLUSION.

The very evident conclusion from observations on Long Island is that large amounts of ground water can still be obtained along the south shore of the island, especially if deep wells of large diameter can be successfully bored. The writer has already called attention to the possibility of constructing 12-inch wells of the California or "stovepipe" type in the unconsolidated material met with to considerable depths on Long Island.[a] Such wells, several hundred feet in depth, with perforations opposite the best water-bearing material, would utilize a large part of the underflow which now escapes to the sea. The practicability and success of such wells in this locality seem very probable, but the actual construction of a test well is the only way of arriving at an entirely satisfactory conclusion.

[a] Slichter, C. S., The California or "stovepipe" method of well construction for water supply: Eng. News, Nov. 12, 1903, p. 429.

CHAPTER IV.

WELL RECORDS ON LONG ISLAND.

Compiled by A. C. VEATCH and ISAIAH BOWMAN.

INTRODUCTION.

The presentation in a compact form of the data and detailed well records collected during the work on Long Island has proved a considerable problem. Presented in the text in connection with the geologic discussion, they furnish the necessary proof of many of the statements there made but so encumber the text that the mind loses itself in the mass of detail. Recourse has therefore been had to the presentation of all the well data in a compact table with notes giving such additional information as may be available. The arbitrary numbers assigned to the wells in the table correspond to those used in the index map (Pl. XXIV) and through the text in Chapters I, II, and V. While an attempt has been made to indicate the geologic subdivisions in some of the records for a critical discussion of their geologic bearing, the reader is referred to the paper on the geology of Long Island, which will be published in a short time.

ACKNOWLEDGMENTS.

Thanks are due to Mr. I. M. De Varona, chief engineer of the Borough of Brooklyn, for access to some of the invaluable records collected by his department; to Mr. L. C. L. Smith, engineer in charge of the Borough of Queens, for many kindnesses and suggestions regarding that borough; to Mr. Cord Meyer and Mr. Edward Meyer, of the Citizens' Water Supply Company, and to Mr. Franklin B. Lord and Charles R. Bettes, of the Queens County Water Company, for much assistance in the study of the fluctuations of well waters.

From the commission on additional water supply, samples were received from the many shallow wells which they put down in their study of the position of the ground-water table. Descriptions of these samples will be found in the descriptive notes following and the results of the sizing and filtration tests in Chapter V.

The well drillers on the island almost without exception rendered valuable assistance, and it is a great pleasure to acknowledge aid from the following sources:

Samuel H. Allen, well driver, 513 Broadway, Long Island City, N. Y.
Arthur & Tuthill, well drivers, Cutchogue, N. Y.
Gilbert Baldwin, well driver, Woodmere, N. Y.

William H. Beers, well driver, Wading River, N. Y.
Ralph B. Carter Company, artesian-well contractors, 47 Dey street, New York City.
Cole Brothers, artesian-well contractors, 102 Fulton street, New York City.
P. H. & J. Conlan, artesian-well contractors, 253 Lafayette street, Newark, N. J.
Chester D. Corwin, artesian-well contractor, 198 Seventh avenue, New York City.
C. H. Danis, artesian-well driller, Cold Spring Harbor, N. Y.
N. W. Davis, artesian-well driller, Port Jefferson, N. Y.
Dollard Brothers, artesian-well drillers, Babylon, N. Y.
H. J. Dubois, artesian-well driller, Huntington, N. Y.
L. J. Dubois, artesian-well driller, Glen Cove, N. Y.
J. Elliott, tile wells, Pinelawn, N. Y.
John Fisher, well driller, Westbury, N. Y.
I. H. Ford, artesian-well contractor, 102 Fulton street, New York City.
C. L. Grant, artesian-well contractor, Hartford, Conn.
Elisha Gregory, artesian-well contractor, 123 Liberty street, New York City.
Paul Haller, well driver, Cedarhurst, N. Y.
W. J. Hancock, well driver, Baldwin, N. Y.
Thomas B. Harper, artesian-well contractor, Jenkinstown, Pa.
John Heerdegen, 44–46 Broadway, New York City.
J. H. Herbert, tubular wells, Floral Park, N. Y.
Hudson Engineer and Contracting Company, water supply engineers, 92 William street, New York City.
E. K. Hutchinson, artesian-well driller, Oyster Bay, N. Y.
W. C. Jeagle, artesian-well driller, Hicksville, N. Y.
Isaac Kasteard, well digger, Port Washington, N. Y.
Thomas J. Kirk, well driver, Patchogue, N. Y.
J. W. Nichols, well driver, Manorville, N. Y.
R. F. Nichols, well driller, Oyster Bay, N. Y.
J. M. Peler, well driver, Manhasset, N. Y.
Phillips & Worthington, artesian-well contractors, 136 Liberty street, New York City.
Pierce Well Engineering and Supply Company, artesian-well contractors, 136 Liberty street, New York City.
Charles E. Price, artesian-well driller, Smithtown Branch, N. Y.
O. W. Quinn, well driller, 257 Seventh avenue, New York City.
J. B. Redwood, well digger, Smithtown, N. Y.
Robinson Brothers, well drivers, Center Moriches, N. Y.
T. B. Rogers, artesian-well driller, Stonybrook, N. Y.
Rust Well Machinery Company, artesian-well contractors, Ithaca, N. Y.
A. O. Ryder, well digger, 227 Franklin place, Flushing, N. Y.
George Schmidt, well driller, East Williston, N. Y.
Ed. Schmidt, well driver, Mineola, N. Y.
Harry Strausbinger, well digger, Shelter Island, N. Y.
H. S. Stewart, well contractor, 354 South Highland avenue, East End, Pittsburg, Pa.
Stotthoff Brothers, artesian-well contractors, Flemington, N. Y.
Sweeney & Gray, consulting engineers and well drillers, 81–85 Sixth street, Long Island City.
John Tart, driller, with Hudson Engineering and Contracting Company, 92 William street, New York City.
S. E. Terry, well borer, Holtsville, N. Y.
Andrew Vandewater, well digger, Hempstead, N. Y.
A. J. Velsor, well digger, Fort Salonga, N. Y.
Lawrence Verdon, well driller, Far Rockaway, N. Y., with Queens County Water Company.
F. K. Walsh, artesian-well driller, Woodmere, N. Y.
Frank Wankel, well driller, 535 Himrod street, Brooklyn, N. Y., with Hudson Engineering and Contracting Company.
Alfred Wisson, well driller, Old Westbury, N. Y.
W. V. Young, artesian-well driller, Baiting Hollow, N. Y.

REPRESENTATIVE WELLS.

TABLE XI.—*Representative*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*1	Hoffmann Island	1 A	New York Quarantine Station.	Elisha Gregory	Elisha Gregory
*2	Fort Lafayette	1 B	U. S. Army		E. Lewis
*3	Bay Ridge	1 B	Brooklyn sewer department.		J. C. Meem, engineer
*4	Bay Ridge Park	1 B	Blythebourne Water Co		L. B. Ward [b]
*5	Brooklyn	1 B	Brooklyn Rapid Transit Co	Elisha Gregory	Brooklyn Rapid Transit Co
6	do	1 C	Milliken Bros	Milliken Bros	Milliken Bros
*7	do	1 C	Barrett Manufacturing Co		Barrett Manufacturing Co
8	do	1 C	P. H. Gill & Sons		P. H. Gill & Sons
9	do	1 C	Crescent Chemical Co		Crescent Chemical Co
*10	Governors Island	1 C	U. S. Army	P. H. and J. Conlan	Elisha Gregory
*11	Ellis Island	1 C		Pierce Well Engineering Co.	Pierce Well Engineering Co.
*12	Brooklyn	1 C	Long Island R. R		C. M. Jacobs, engineer
*13	New York-Brooklyn	1 C, 2 C	Rapid Transit		Chief engineer
14	Manhattan Beach	2 A	Manhattan Beach Hotel	Dollard Bros	Dollard Bros
15	New Utrecht pumping station.	2 B	Brooklyn waterworks		L. B. Ward [b]
*16	Gravesend pumping station.	2 B	do	W. D. Andrews & Bro.	do.[b]
17	Gravesend	2 B	Brooklyn Borough Gas Co.		Brooklyn Borough Gas Co.
*18	Mapleton	2 B	Pfalzgraf estate		L. B. Ward [e]
*19	Borough Park	2 B	(West Brooklyn Water Co.)		I. M. De Varona [f]
*20	West Brooklyn	2 B	do		do.[g]
21	Blythebourne	2 B	Blythebourne Water Co		do.[f]
22	Flatbush	2 B	Flatbush Water Co		L. B. Ward
	Brooklyn:				
*23	8th avenue and 18th street.	2 B	The Maltine Co	Foster Pump Works	The Maltine Co
24	12th street and Gowanus Canal.	2 C	Brooklyn Union Gas Co		Brooklyn Union Gas Co
*25	9th street and Gowanus Canal.	2 C	Tartar Chemical Co	Elisha Gregory	Elisha Gregory
26	Hoyt and 5th avenue	2 C	Brooklyn Union Gas Co		Brooklyn Union Gas Co
*27	3d avenue and 3d street.	2 C	Transit Development Co		Samples in office of Transit Development Co.
*28	3d avenue, between Degraw and Douglass streets.	2 C	Brooklyn Union Gas Co		Brooklyn Union Gas Co
*29	Dean street, near Vanderbilt avenue.	2 C	Humbert & Andrews	Chester D. Corwin	Chester D. Corwin
*30	St. Marks and Grand avenues.	2 C	Knox Hat Co	Elisha Gregory	Elisha Gregory
*31	Lewis and De Kalb avenues.	2 C	Borden Condensed Milk Co.	Chester D. Corwin	Chester D. Corwin

* For additional data see descriptive notes, pp. 168 et seq.
[a] Yield from a single shaft.
[b] Merchants' Association report on water supply of the city of New York, 1900, table following p. 186.
[c] Average per well for 1899.
[d] See Table VIII.

REPRESENTATIVE WELLS.

wells on Long Island.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Yield per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
8	1,000	750–1,000	.....	33	Cambro-Silurian (?)..	Rock encountered at a depth of 450 feet.....	1
.....	53	.....	.....	.....	.....	Foundation test borings.....	2
.....	40–90	.....	.....	[a] 520–695	Wisconsin.....	Sewer tunnel.....	3
60	90	.....	.....	[c] 139	.....do.....	See Table VIII	4
240	90						
8–6	1,503	.....	.....	.....	Cambro-Silurian.....	Salt water.....	5
2½	65	65	− 10	100	Wisconsin.....	Hard water; used only for cooling	6
8	50	50	− 10	.....	.....do.....	Used for cooling purposes only	7
4–2	50	.....	− 35	.....	.....do.....	Water salty and hard.....	8
6	56	52	− 15	40	.....do.....	Slightly brackish; not used for boiler or drinking.	9
12–8	1,822.5	1,715	Flows.	15	Cambro-Silurian.....	Salty water.....	10
8	1,400	.....	.....	.....	.....	Brackish water.....	11
.....	120	.....	.....	.....	.....	Test boring.....	12
.....	12–102	.....	.....	.....	Pleistocene; Cambro-Silurian.	.....do.....	13
.....	40	.....	− 10	.....	Pleistocene.....	Coarse sand and gravel.....	14
2	30	.....	− 3.6	[c] 6.5	Wisconsin.....	Group of 120 driven wells	[d] 15
2	50	.....	− 17.4	[c] 15	.....do.....	Group of 113 driven wells	[d] 16
.....	14	.....	.....	.....	.....	Blue clay at a depth of 14 feet.....	17
.....	.....	.....	.....	.....	.....	Single well used for local water supply.....	[d] 18
8	.....	.....	.....	.....	.....	Reserve station of old West Brooklyn Water Co.	19
96	65	.....	− 60	.....	.....	Principal station of old West Brooklyn Water Co.	20
7	60	.....	.....	.....	Wisconsin.....	Reserve station; not used	[d] 21
96–5	44	.....	.....	.....	.....	.....	[d]22
5	55	.....	.....	[c] 27	Wisconsin	Group of 55 wells.....	
96–8	177.5	157.5–177.5	−157.5	500	Tisbury?.....	Used for cooling and manufacturing; slightly hard.	23
6	65	.....	.....	[f] 100	.....	2 wells.....	24
8	143	140	− 6	[f] 1,200	Jameco?.....	2 wells; water not used for boilers.....	25
4½	40	.....	.....	[f] 20	.....	Group of 5 wells.....	26
2	30–50	.....	.....	.....	.....	Test borings for foundations.....	27
6–4½	72–90	.....	.....	[f] 38	Jameco?.....	Group of 11 wells.....	28
6	98	81–98	− 75	40+	Tisbury?.....	.....	29
10	331	217	.....	.....	Jameco.....	Bed rock at 331 feet.....	30
8	101	.....	− 67	100	Tisbury.....	.....	31

[c] Op. cit., p. 181.
[f] History and Description of the Water Supply of Brooklyn, 1896, p. 139.
[g] Op. cit., p. 138.
[i] Average of each well.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
	Brooklyn—Continued.				
32	Pulaski street and Lewis avenue.	2 C....	H. B. Scharmann & Sons....	.....	H. B. Scharmann.....
*33	254 Hart street.....	2 C....	Excelsior Brewing Co.....	Elisha Gregory.....	Elisha Gregory.....
34	Central avenue and Grove street.	2 C....	Jos. Epping.....	Pierce Well Engineering Co.	Pierce Well Engineering Co.
*35	Forest street and Evergreen avenue.	2 C....	S. Liebmann Sons Brewing Co.	.....	Alfred Liebmann.....
36	Noll and Bremen streets.	2 C....	Obermeyer & Liebmann....	.....	E. Obermeyer.....
*37	Bartlett street and Harrison avenue.	2 C....	Pfeizer Chemical Co.....	C. D. Corwin.....	C. D. Corwin.....
*38	Bartlett street and Flushing avenue.	2 C....	.....do.....	Phillips & Worthington.	Phillips & Worthington....
39	Flushing and Franklin avenues.	2 C....	Malcom Brewing Co	Stotthoff Bros.....	Stotthoff Bros.[a].....
*40	20–34 Ryerson street.	2 C....	Merger & Thrall (?).....	C. D. Corwin.....	C. D. Corwin.....
*41	163 Carlton avenue..	2 C....	Walter M. Debevoise.....	I. H. Ford.....	I. H. Ford.....
*42	Between Wallabout and Gowanus.	2 C....	(—— Johnson).....	.....	W. W. Mather[b].....
*43	Clarke, Willow, and Pineapple streets.	2 C....	.....	.....	Arthur Hollick[c].....
44	66 Water street.....	2 C....	Sweeney Manufacturing Co.	I. H. Ford.....	I. H. Ford.....
*45	Brooklyn Bridge....	2 C....	.....	.....	Long Island Historical Society.
*46	Pearl and Front streets.	2 C....	Jones Bros.....	.....	.....
*47	50 Jay street.....	2 C....	John W. Masury & Son....	Pierce Well Engineering Co.	Pierce Well Engineering Co. John W. Masury & Son....
*48	John and Jay streets.	2 C....	Arbuckle Bros.....	H. S. Stewart.....	H. S. Stewart.....
49	Bridge and Plymouth streets.	2 C....	Howard & Fuller Brewing Co.	.....	Howard & Fuller.....
50	Brooklyn Navy-Yard	2 C....	U. S. Navy.....	.....	Civil engineer of navy-yard.
*51	Brooklyn Navy-Yard	2 C....	.....do.....	F. Wankel.....	F. Wankel.....
*52	Brooklyn Navy-Yard	2 C....	.....do.....	.....do.....	.....do.....
*53	Brooklyn Navy-Yard	2 C....	.....do.....	.....do.....	.....do.....
*54	Brooklyn Navy-Yard	2 C....	.....do.....	.....	Civil engineer of navy-yard.
*55	556 Kent avenue.....	2 C....	Brooklyn Union Gas Co....	.....	Brooklyn Union Gas Co....
56	Keap street and Kent avenue.	2 C....	Chrome Steel Works.....	.....	T. I. Jones, treasurer.....
57	Harrison and Broadway streets.	2 C....	The J. H. Shults Co.....	.....	The J. H. Shults Co.....
58	Leonard and Meserole streets.	2 C....	Burger Brewing Co.....	.....	L. G. Burger.....
59	Meserole and Humbolt streets.	2 C....	Congress Brewing Co.....	.....	James D. Long, manager...
*60	Bushwick and Meserole avenues.	2 C....	Eastern Brewing Co.....	Chester D. Corwin.....	Chester D. Corwin.....
61	White and Boerum streets.	2 C....	F. H. Klabfleisch Co.....	.....	F. H. Klabfleisch Co.....

*For additional data see descriptive notes, pp. 168 et seq.
[a] Ann. Rept. Geol. Survey New Jersey for 1898, 1899, p. 137.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Yield per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
.....	105	.....	.....	.....	.....	Nothing but sand.....	32
10	138	.....	.....	200	Pleistocene.....	.....	33
6	100	.....	−10	100	.....do.....	Brown sand, 0 to 100 feet.....	34
.....	275	63–105	−63	.....	.....	.....	35
.....	60–70	.....	.....	.....	.....	3 wells; all sand.....	36
6	165	150–165	− 5	360	.....	.....	37
8	176	124–176	− 7	350	Pleistocene.....	.....	38
.....	62	.....	.....	.....	.....	Water 8 feet from cellar floor.....	39
2	84	.....	.....	0	.....	Bed rock at 84 feet.....	40
.....	90	.....	.....	.....	.....	.....	41
.....	84	.....	.....	.....	.....	.....	42
.....	65	.....	.....	.....	Pleistocene.....	.....	43
4	60	.....	.....	.....	.....do.....	Bowlder clay.....	44
.....	89	.....	.....	.....	.....	Foundation sounding.....	45
.....	60	21–60	−12	.....	.....	.....	46
6	100	.....	.....	300	Pleistocene.....	.....	47
5–6	53–75	.....	− 7	225	.....do.....	Group of wells. Water rather hard.....	
.....	2,148	.....	.....	.....	.....	Bed rock at 93. No water in rock.....	48
.....	800	.....	.....	.....	.....	Bed rock at 97.....	
4	50	.....	Flows.	50	Pleistocene.....	Coarse reddish sand, 0 to 50 feet.....	49
.....	50	.....	.....	.....	.....	Struck rock or bowlders and abandoned...	50
6	316	275	−50	60	Silurian?.....	Bed rock at 103 feet.....	51
		296	−50	80			
6	220	190	.....	60	.....do.....	Bed rock at 96 feet.....	52
6	108	.....	.....	.....	.....	Nothing but brackish water. Rock at 101 feet.	53
.....	.....	.....	.....	.....	.....	Record of beds penetrated in dry-dock excavations.	54
3	129.5	.....	.....	100	Pleistocene.....	Original yield in 1873, 500 gallons per minute.	55
4	85	.....	.....	100	.....do.....	.....	
6	85	.....	.....	100	.....do.....	2 wells.....	
.....	65	.....	.....	.....	.....	.....	56
4	65	.....	−20	5	Pleistocene.....	Hard water; temperature, 50° F.....	57
.....	35–45	.....	.....	.....	.....	All sand.....	58
.....	140	90	.....	.....	.....	Blue clay, 90 to 140 feet.....	59
8	117	101–117	−51	400	Pleistocene.....	.....	60
4½	50	.....	−15	.....	.....do.....	Used for cooling purposes only.....	61

[b] Geology of the First District, 1843, p. 259.
[c] Trans. N. Y. Acad. Sci., vol. 12, p. 225.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
	Brooklyn—Continued.				
*62	Ten Eyck street, between Bushwick and Florence	2 C....	N. Seltz's Sons.....	Phillips & Worthington I. H. Ford.....	Phillips & Worthington.... I. H. Ford.....
63	Montrose and Seneca streets.	2 C....	Robinson Bros.....	.....	Robinson Bros.....
*64	Maspeth and Gardiner avenues.	2 C....	Peter Cooper Glue Co.....	.....	Peter Cooper Glue Co.....
*65	Porter and Maspeth avenues.	2 C....	Brooklyn Union Gas Co....	.....	..... Brooklyn Union Gas Co ....
*66	Meeker and Kingsland avenues.	2 C....	Neptune Consumers Ice Co.	I. H. Ford.....	C. Harty, foreman.....
*67	Meeker avenue, between North Moore and Monitor streets.	2 C....	.....	Chester D. Corwin.....	Chester D. Corwin.....
68	Wythe and Metropolitan avenues.	2 C....	Streeter & Dennison.....	.....	Streeter & Dennison.....
69	Kent avenue and North 12th street.	2 C....	Brooklyn Union Gas Co....	.....	Brooklyn Union Gas Co....
70	110–118 North 11th street.	2 C....	Hecla Iron Works.....	.....	Hecla Iron Works.....
*71	99–117 North 11th street.	2 C....	New York Quinine and Chemical Co.	The Rust Well Machinery Co.	New York Quinine and Chemical Co.
*72	Kent and 12th streets.	2 C....	Standard Oil Co.....	.....	H. L. Pratt.....
73	Noble and West streets.	2 C....	American Cordage and Manufacturing Co.	P. H. & J. Conlan..... Elisha Gregory.....	P. H. & J. Conlan [a] ..... Elisha Gregory.....
74	Fly Island, Newtown Creek.	2 C....	Empire Oil Refinery.....	I. H. Ford.....	I. H. Ford.....
	Long Island City:				
*75	Blissville.....	2 C....	Fleischmann Manufacturing Co.	.....	Jacob Blumer, chemist.....
*76	Blissville.....	2 C....	Standard Oil Co.....	.....	Chas. O'Conner, superintendent.
77	Laurel Hill.....	2 C....	Nichols Chemical Co.....	P. H. & J. Conlan..... Nichols Chemical Co....	P. H. & J. Conlan [c]..... Nichols Chemical Co.....
78	Laurel Hill.....	2 C....	General Chemical Co.....	General Chemical Co...	General Chemical Co.....
*79	New Calvary Cemetery.	2 C....	Calvary Cemetery.....	Pierce Well Engineering Co.	E. Lewis [d].....
*80	.....	2 C....	.....	Commission.....	Commission.....
81	Van Dam street.....	2 C....	Department Water Supply, gas and electricity.	.....	L. B. Ward [e].....
*82	.....	2 C....	Flower estate.....	Pierce Well Engineering Co.	Chas. D. Pierce, manager ...
*83	.....	2 C....	.....	Commission.....	Commission.....
84	.....	2 C....	Flower estate.....	Pierce Well Engineering Co.	Pierce Well Engineering Co.
*85	Manhattan Borough to Thomson street.	2 C....	Pennsylvania, New York and Long Island R. R.	.....	Chief engineer.....
*86	Near depot.....	2 C....	Westinghouse Electric Co...	W. E. Dohrman.....	W. E. Dohrman.....
*87	6th and West	2 C....	A. & S. B. Coyson.....	Sweeney & Gray	Sweeney & Gray.....
*88	Vernon avenue.....	2 C....	Jas. Gillis & Sons.....	Pierce Well Engineering Co.	Pierce Well Engineering Co.

* For additional data see descriptive notes, pp. 168 et seq.
[a] Ann. Rept. Geol. Survey New Jersey for 1900, 1901, p. 156.
[b] Originally —5.
[c] Ann. Rept. Geol. Survey New Jersey for 1897, 1898, p. 284.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Yield per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
8	240	52–75	.....	400	Tisbury?	.....	62
12–9	160	58–76	.....	100	.....do	.....	
72	15	.....	− 10	50	Wisconsin	Hard water used for cooling	63
3	30	19	− 19	10	.....do	Temperature, 54°. Six wells	64
.....	190	48 190	− 24	200	.....	.....	65
6	54	.....	.....	125	.....	.....	
10–8–6	225	28–32	.....	.....	Wisconsin	No water below 32 feet	66
8	73	63–70	.....	.....	.....	.....	67
.....	60	.....	.....	.....	.....	"Water cold and pure and plenty of it".	68
4	46	.....	.....	2	.....	.....	69
6	60	.....	.....	7	Wisconsin	Hard water	70
10	333	.....	− 10	125	Silurian?	Rock below 125 feet. Not used for drinking.	71
.....	±200	.....	.....	.....	.....	Struck rock and abandoned	72
.....	80	.....	.....	.....	.....	Brackish water	73
8	610	.....	.....	.....	.....	Rock, 90 to 610 feet; brackish water	
.....	300	.....	.....	.....	.....	Rock, 100 to 300 feet	74
6	60–70	.....	− 40	200	Pleistocene	Water lowered from −15 to −40 feet	75
6	275–450	.....	−220 −250	10–125	Silurian ?	Rock below 124 feet	
180–6	60–70	.....	[b]− 60	.....	Pleistocene	.....	76
.....	100–135	.....	.....	75–100	.....do	Water of good quality	77
10	60	.....	− 15	66	.....	Group of 6 wells. Used only for cooling	
4	66	.....	.....	.....	.....	.....	78
.....	582	.....	.....	70	.....	Gneiss, 182–582 feet	79
2	38	.....	.....	.....	.....	.....	80
6	70	.....	.....	[f]474	.....	Long Island City pumping station No. 1	[g]81
570	30						
8	145	90–100	.....	75	Tisbury	Rock, 112 to 145 feet; no water	82
2	40	.....	.....	.....	.....	.....	83
6	100	.....	− 6	.....	.....	Rock, 50 to 100 feet	84
.....	10–150	.....	.....	.....	.....	Test borings for East River Tunnel	85
.....	69	.....	.....	.....	.....	Test borings for foundations	86
.....	152	152	−19	72	.....	Gneiss, 22–152 feet; brackish water	87
8	100	.....	.....	100	.....	Rock, 30 to 100 feet; brackish water	88

[d] Annals N. Y. Acad. Sci., vol. 3, p. 346; Bull. U. S. Geol. Survey No. 138, p. 34.
[e] Merchants' Association report on water supply of the city of New York, 1900, table following p. 186.
[f] Average from station for 1899.
[g] See Table VIII.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
	Long Island City—Con.				
*89	Vernon and Nott avenues.	2 C.	C. A. Willey & Co.	Sweeney & Gray	Sweeney & Gray
90	Skillman avenue and School street.	2 C.	Mrs. Mary Ryan		S. H. Allen
*91	Skillman avenue and School street.	2 C.	Bragnaw estate	S. H. Allen, foreman	do
*92	596 Jackson avenue.	2 D.	Gus. Steinhert	Sweeney & Gray	Sweeney & Gray
*93	Jackson avenue and Hill street.	2 D.	Long Island R. R.		Long Island R. R.
*94	Long Island R. R. and Remsen street.	2 D.	Westcott Express Co.	S. H. Allen	S. H. Allen
*95	Millersburg avenue and Moore street.	2 D.	—— Smith	do	do
*96	Buckley and Middleburg.	2 D.		Sweeney & Gray	Sweeney & Gray
97		2 D.	Ed. O'Kiefe	S. H. Allen	S. H. Allen
*98	Long Island R. R. and Lowery street.	2 D.	Consumers Hygeia Ice Co.	do Sweeney & Gray	do Sweeney & Gray
*99	Long Island R. R. and Grove street.		Department water supply, gas, and electricity.	 Commission	L. B. Ward [b] A. S. Farmer Commission
*100	Steinway avenue between Pierce and Graham.	2 D.		S. H. Allen	S. H. Allen
*101	5th avenue between Pierce and Graham.	2 D.		do	do
*102	Washington and 4th avenues.	2 D.	Frank Froellich	do	do
103	2d avenue between Pierce and Washington avenues.	2 D.	Martin Hummel	do	do
*104	Pierce avenue and Crescent street.	2 D.	Mrs. Wonder	do	do
*105	Williams street and Beebe avenue.	2 D.	W. J. Matherson & Co.	C. C. Vermeule	W. J. Matherson & Co.
*106	Ely between Paynter and Beebe avenues.	2 D.		S. H. Allen	S. H. Allen
107	Hancock avenue near Bodine street.	2 D.	Emken Chemical Co	Sweeney & Gray	Sweeney & Gray
108	337 Vernon avenue.	2 D.	Young & Metzner	do	do
109	Vernon and Harris avenues.	2 D.	D. G. Morrison	do	do
*110	401 Vernon avenue.	2 D.	New York Architectural Terra Cotta Co.	do	do
111	Vernon avenue	2 D.	John Good Cordage and Machine Co	Pierce Well Engineering Co.	Pierce Well Engineering Co.
112	Vernon avenue	2 D.	Young Bag Co.	do	do
113	Vernon avenue	2 D.	East River Gas Co.	do	do
114	725 Vernon avenue.	2 D.	Witherspoon & Son	Sweeney & Gray	Sweeney & Gray
*115		2 D.	New York Asbestos Co	F. W. Miller	
*116	Broadway and Academy street.	2 D.	Wm. Siebrecht	Sweeney & Gray	Sweeney & Gray
*117	9th and Jamaica avenues.	2 D.	Rudolph Harek	S. H. Allen	S. H. Allen

*For additional data see descriptive notes, pp. 168 et seq.
[a] Several inches.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Yield per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
.....	85	85	(a)	.....	.....	Gneiss, 25 to 85 feet.	89
4	31	.....	+ 2	8	Wisconsin	Group of 4 wells; all flowing; pumps 78 gallons per minute.	90
1½	30	30	+ 3	15	.....do	Well now entirely clogged up	91
6	30	.....	− ½	.....	.....	.....	92
.....	30	.....	Flows.	.....	.....	Slight flow	93
36–1½	53	42–53	.....	.....	.....	.....	94
2	38	.....	Flows.	.....	.....	.....	95
.....	19	.....	0	.....	.....	.....	96
2	42	.....	−16	.....	.....	.....	97
4	51-66	.....	− 3 − 5	48–60	Pleistocene	.....	98
6	62	.....	−22	.....	.....do	.....	
4	41	.....	−10	36	Tisbury	Long Island City pumping station No. 3	99
.....	125	.....	.....	.....	.....	Fordham gneiss, 118 to 125 feet	
.....	42	.....	.....	.....	.....	.....	
?	43	.....	+ 0.7	14	.....	.....	100
1½	60	.....	−30	.....	.....	Rock at 60 feet; water level formerly −18	101
1½	57	.....	−30	.....	.....	.....	102
36	63	.....	−55	.....	.....	Rock, at 63 feet	103
3	74	.....	.....	.....	.....	.....	104
240	30	.....	0	34	.....	Used for manufacturing	105
2	22	.....	+ 2	5	.....	.....	106
6	80	.....	.....	.....	Fordham gneiss	Gneiss,8 to 80 feet; water slightly brackish	107
.....	125	.....	− 5	.....	.....do	Gneiss, 6 to 125 feet; brackish water	108
.....	125	.....	−25	.....	.....do	Gneiss, 0 to 125 feet; brackish water	109
6	115	.....	−40	.....	.....do	Gneiss, 22 to 115 feet; brackish water	110
6	350	.....	−20	50	.....do	Gneiss, 20 to 350 feet	111
8	150	.....	−25	.....	.....do	Gneiss, 20 to 150 feet	112
6	100	.....	(?)	75	.....do	Gneiss, 20 to 100 feet; well probably abandoned.	113
6	125	.....	−40	.....	.....do	Gneiss, 0 to 125 feet; water very brackish	114
4½–3	31	.....	Flows.	.....	Pleistocene	Rock at 31 feet	115
6	90	.....	−18	Good	.....do	Brackish waters	116
36–2	74	.....	−43	.....	.....	.....	117

[b] Annals N. Y. Acad. Sci., vol. 3, p. 346; Bull. U. S. Geol. Survey No. 138, p. 34.
[c] See Table VIII.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
	Long Island City—Con.				
*118	408 9th avenue	2 D		S. H. Allen	S. H. Allen
*119	Steinway and Jamaica avenues.	2 D	Dr. Harnier	do	do
*120	Albert street and Jamaica avenue.	2 D	Chas. Bickerman	do	do
*121	12th between Broadway and Jamaica avenue.	2 D		do	do
*122	Grand street and 3d avenue.	2 D	Commission		Commission
*123	Elm street and Hopkins avenue.	2 D	Mrs. Fleming	S. H. Allen	S. H. Allen
124	Fulton and Halsey streets.	2 D	Ward's ship yards	do	do
*125	Munson and Orchard streets.	2 D	Astoria Steel Co	Elisha Gregory	Elisha Gregory
*126	Steinway avenue and River road.	2 D	Consolidated Gas Co		Phillips & Worthington
127	Woolsey and Van Alst avenues.	2 D	Newwitter & Migel		S. H. Allen
*128		2 D		S. H. Allen	do
*129	Barren Island	3 A	—— McKlevery	Thos. B. Harper	Thos. B. Harper
*130	do	3 A	Thos. F. White Co	do	Lewis Woolman[a]
*131	do	3 B	New York Sanitary Utilization Co.	do	do.[a]
*132	do	3 B	do	Chester D. Corwin	Chester D. Corwin
*133	Crook Island	3 B	White Lead Co	do	do
	East New York:				
*134	Pennsylvania and Stanley avenues.	3 B	German American Improvement Co.		L. B. Ward
*135	New Lots road and Fountain avenue.	3 C	Department water supply, gas, and electricity.		Robt. Van Buren, engineer. L. B. Ward[d]
*136	Brooklyn Aqueduct	3 C	do		I. M. De Varona[f]
*137	Brooklyn Aqueduct	3 C	do		do.[g]
					do.[h]
*138	Old Spring Creek pumping station.	3 C	do		L. B. Ward[d]
				W. D. Andrews & Bro	W. D. Andrews & Bro
*139	Temporary Spring Creek pumping station.	3 C	do		I. M. De Varona[i] L. B. Ward
140	Ridgewood pumping station.	3 C	do		I. M. De Varona[n]
*141	Jamaica avenue and Aqueduct.	3 C	do		do.[g]
*142	Woodhaven	3 C	Woodhaven Water Supply Co.		L. B. Ward[d]

*For additional data see descriptive notes, pp. 168 et seq.
[a] Ann. Rept. New Jersey Geol. Survey for 1896, pp. 155–156.
[b] Average per well for 1899.
[c] See Table VIII.
[d] Merchants' Association report on water supply of the city of New York, 1900, table facing p. 186.
[e] Report of P. H. & J. Conlan, drillers: Ann. Rept. Geol. Survey New Jersey for 1898, p. 142.
[f] Ann Rept. Dept. City Works, Brooklyn, 1896, p 298.
[g] History and Description of the Brooklyn Waterworks, 1896, pl. 40
[h] Op. cit., p. 20.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Yield per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
.....	57	.....	.....	.....	.....	Marine shells at 50 feet	118
.....	65	.....	−47	.....	.....	.....	119
.....	60	42–60	−42	.....	.....	.....	120
.....	65	.....	.....	.....	.....	.....	121
2	31	.....	.....	.....	.....	.....	122
.....	35	.....	− 1	10	.....	Rock at 35 feet	123
.....	22	.....	.....	.....	.....	Well unsatisfactory; rock at 22 feet	124
10–8	608	.....	.....	.....	.....	Rock 28 to 608 feet; salty water	125
3	55	.....	− 4	18	Fordham gneiss	Hard water	126
.....	100	.....	.....	.....	.....	Abandoned	127
2	48	.....	− 1	.....	.....	Bad water at 14 feet	128
6	740	.....	Flows.	.....	Lloyd gravel	.....	129
6	740	.....	+10	103	.....do	.....	130
6	720	.....	+10	50	.....do	.....	131
10–4½	700	.....	− 4	.....	.....do	Pumps 105 gallons per minute	132
2	134	.....	.....	.....	.....	Salt water at 134 feet	133
6	60	.....	.....	.....	.....	.....	
6	65	.....	.....	[b] 16	.....	.....	[c]134
6	70	.....	.....	.....	.....	.....	
6	168	.....	.....	.....	Jameco	New Lots pumping station [e]	
2	45–50	.....	.....	.....	.....	.....	135
6	80–90	.....	.....	[e] 270	Wisconsin and Tisbury.	Average for whole station of 40 wells for 1899 was 3,007 gallons per minute.	(c)
288–6	24+	.....	.....	.....	.....	.....	
5	191	.....	.....	None.	.....	Brooklyn waterworks test well No. 17	136
5	148	.....	− 2.5	.....	Jameco	Brooklyn waterworks test well No. 4	137
2	30–41	.....	.....	[f] 80–103	Wisconsin	Test of 1894	
2	36	.....	.....	.....	.....do	.....	
6	[g]150	.....	−12.1	[j] 2,759	Jameco	.....	138
8	150	.....	.....	.....	.....do	.....	(c)
2	100+	.....	+ 2	[k] 30–40	.....	Test wells sunk in 1882	
6	42–75	.....	.....	[m] 240	Wisconsin and Tisbury.	Test in 1894; group of 13 wells	139
6	42–75	.....	−11	160	.....do	Average for 1899	(c)
.....	.....	.....	.....	Good.	.....do	Temporary pumping station yielded 4,000,000 gallons daily.	[c]140
5	284	.....	−46	Good.	Jameco	Brooklyn waterworks test well No. 5.	141
4	80–150	.....	−30	[b] 24	Wisconsin and Tisbury.	Group of 16 wells	[c]142
6							

[f] Tests of separate wells. Average per well for test of whole plant at same time 30+ gallons.
[j] Average for whole station of 108 wells for 1899.
[k] With a hand pump.
[l] History and Description of the Brooklyn Waterworks, 1896, p. 21.
[m] Average yield in 1899 was 160 gallons.
[n] Op. cit., p. 100.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*143	Woodhaven	3 C	Lalance & Grosjean Manufacturing Co.		John Bryson[a]
*144	Union Place	3 C	Commission		Commission
*145	Glendale	3 C	....do		....do
146	Evergreen	3 C	The Frank Brewery		The Frank Brewery
*147	Metropolitan	3 C	Montauk Brewing Co		Montauk Brewing Co
*148	Middle Village	3 C	Commission		Commission
*149	Middle Village	3 C	H. Bottjer	Ed. Schmidt	Ed. Schmidt
150	Flushing Creek	3 C	Citizens' Water Supply Co		J. Edward Meyer, superintendent.
*151	Flushing Creek	3 C	....do		....do
*152	Flushing Creek	3 C	Commission		Commission
*153	Maspeth	3 C	Woodside Water Co		
*154	New Calvary Cemetery	3 C	New Calvary Cemetery	S. H. Allen	S. H. Allen
*155	New Calvary Cemetery	3 C	...do	....do	....do
*156	New Calvary Cemetery	3 C	...do	....do	....do
*157	Newtown	3 C	Commission		Commission
158	Newtown	3 C	Citizens' Water Supply Co		L. B. Ward
*159	Elmhurst	3 C	Commission		Commission
*160	Woodside	3 D	New York and Queens County R. R.	S. H. Allen	S. H. Allen
*161	Do	3 D	Woodside Water Co		
*162	Do	3 D	Citizens' Water Supply Co	Stotthoff Bros	L. B. Ward Lewis Woolman[f]
	Long Island City:				
*163	Albert street near Grand avenue.	3 D	I. Isenburg	S. H. Allen	S. H. Allen
*164	Grand and 9th avenues.	3 D		....do	....do
*165	13th avenue near Vandeventer.	3 D		....do	....do
*166	Bowery Bay road near Flushing avenue.	3 D	Commission		Commission
*167	Albert street and Ditmars avenue.	3 D	Commission		....do
*168	Steinway avenue	3 D	Astoria Silk Works	S. H. Allen	S. H. Allen
*169	Potter avenue near Park place	3 D	—— Dillman	....do	....do
*170	Merchant street and Ditmars avenue.	3 D	Rivercrest Sanitarium	....do	....do
*171	Near Merchant street and Ditmars avenue.	3 D	....do	....do	....do
*172	Crescent street near Ditmars avenue.	3 D	....do	....do	....do
*173	Lawrence street and Wolcott avenue.	3 D	Commission		Commission
174	Bowery Bay	3 D	Steinway & Son	Pierce Well Engineering Co.	Pierce Well Engineering Co.

*For additional data see descriptive notes, pp. 168 et seq.
[a] Am. Geol., vol. 2, 1888, pp. 136–137; vol. 3, 1889, pp. 218–219.
[b] Estimate for whole station.
[c] See Table VIII.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Yield per minute.	Geologic horizon of water-bearing strata.	Remarks.	No
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
.....	577	.....	.....	0	.....	Gneiss 556 to 577 feet	143
2	46	.....	.....	.....	.....	Commission No. 567	144
2	76	.....	.....	.....	.....	Commission No. 1372	145
96	110	.....	−85	104	Pleistocene	Temperature 50° F.	146
6	106	.....	.....	.....	do		147
5	109	109	.....	100	do	Temperature 51° R.	
2	96	.....	.....	.....	.....	Commission No. 1204	148
2	135	.....	−35	.....	.....		149
6	50	.....	Flows.	[b] 1,735	Pleistocene	Station No. 4; group of 16 wells	[c]150
4½–6	50	.....	Flows.	[b] 1,388	do	Station No. 5; group of 13 wells	151
	190	50–90	.....	.....	.....	Test well; no water below 90 feet	[c]
2	22	.....	.....	.....	.....	Commission No. 1188	152
.....	.....	.....	.....	.....	.....	Pumping station No. 1	[c]153
6	70	.....	Flows.	.....	Pleistocene	Rock at 80 feet; pumps 80 gallons per minute.	154
8	51	.....	− 1	80	do		155
8	56	.....	−26	80	do		156
2	26	.....	.....	.....	.....	Commission No. 1189	157
6	45–62	.....	.....	[d] 15	Wisconsin	Pumping station No. 1; 28 wells	[c]158
2	69	.....	.....	.....	do	Commission No. 662	159
4	32	.....	− 2	85			
4	52	.....	− 8	30	Pleistocene		160
4	60	.....	.....	40			
.....	.....	.....	.....	.....	.....	Pumping station No. 2	[c]161
4½	45–80	.....	[e] −15	[d] 14	Pleistocene	Pumping station No. 2; 78 wells	162
.....	227	.....	.....	0		Gneiss, 138 to 227 feet	[c]
.....	61	.....	.....	.....	do		163
.....	60	.....	.....	.....	do		164
.....	72	.....	.....	.....	do		165
2	40	.....	.....	.....	.....	Commission No. 827; rock at 40 feet, probably a bowlder.	166
2	40	.....	.....	.....	.....	Commission No. 828	167
8	112	80	.....	210	Pleistocene		168
.....	63	.....	.....	.....	do		169
.....	48	.....	−31	200	.....	Group of 3 wells	170
.....	70	.....	−59	.....	.....	Water in crevice in rock	171
36	42	.....	.....	35–40	.....		172
2	31	.....	.....	.....	.....	Commission well No. 859	173
6	100	.....	− 6	.....	.....	Rock, 50 to 100 feet	[c]174

[d] Average per well for 1899.
[e] Report of J. Ed. Meyer, who states that a few of these wells were originally artesian.
[f] Ann. Rept. New Jersey Geol. Survey for 1899, 1900, p. 80.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
	Long Island City—Con.				
175	Cabinet and Bowery Bay road.	3 D	Department water supply, gas, and electricity.		L. B. Ward
*176	North Beach	3 D	Bowery Bay Building and Improvement Association.	Sweeney & Gray	L. C. L. Smith, consulting engineer.
*177	North Beach	3 D			
*178	Flushing and Ehret avenues.	3 D	Woodside Water Co		
*179	Trains Meadow and Highway roads.	3 D	Commission		Commission
*180	Trains Meadow road near Jackson avenue.	3 D	do		do
*181	Junction avenue and Strongs Lane.	3 D	do		do
*182	College Point	3 D	India Rubber Comb Co		A. D. Schlissinger, president
183	do	3 D	—— Stonebanks		A. D. Schlissinger
*184	do	3 D	American Hard Rubber Co.	Chester D. Corwin	Chester D. Corwin
185	do	3 D			A. D. Schlissinger
*186	Tallman Island	3 D	Long Island R. R.		C. M. Jacobs, consulting engineer.
*187	Far Rockaway	4 B	Jas. Caffery	Lawrence Verdon	Lawrence Verdon
*188	do	4 B	B. L. Carroll	Gilbert Baldwin	Gilbert Baldwin
*189	do	4 B	Jas. Caffery	F. K. Walsh	F. K. Walsh
*190	do	4 B	Long Island R. R		Long Island R. R
*191	do	4 B	Queens County Water Co	C. A. Lockwood	C. A. Lockwood
192	Nigger Point	4 B	Idlewild Hotel		Theo. R. Chapman
*193		4 B	Theo. R Chapman	Theo. R. Chapman	do
194	Shetucket pumping station.	4 B	Department water supply, gas, and electricity.		L. B. Ward
*195	do	4 B	do		I. M. De Varona
*196	Springfield pumping station.	4 B	do		L. B. Ward Peter C. Jacobsen [c]
*197	Near Springfield pumping station.	4 B	do		I. M. De Varona
198	Oconee pumping station	4 C	do		L. B. Ward
*199	Near Oconee pumping station.	4 C	do		I. M. De Varona
*200	Baisley's pumping station.	4 C	do	W. D. Andrews & Bro.	W. D. Andrews & Bro. I. M. De Varona L. B. Ward I. M. De Varona
*201	Jameco pumping station.	4 C	do	do	do L. B. Ward
*202	Aqueduct and Cornell Creek.	4 C	do		I. M. De Varona
*203	Aqueduct and Rockaway road.	4 C	do		do

* For additional data see descriptive notes, pp. 168 et seq.
[a] Average yield to pumps per minute from whole station, 1899.
[b] See Table VIII.
[c] Reports to Chief Engineer I. M. De Varona.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Yield per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
4	45						
192	22	.....	Flows.	[a]557	Pleistocene.....	Long Island City station No. 2; 29 wells ...	[b]175
6	70	.....	−12	20	.....do.....	Group of 17 wells	[b]176
6	40–50	.....	.....	.....	.....	Group of 3 wells.....	177
.....	.....	.....	.....	.....	.....	Station No. 3; not used	[b]178
2	28.5	.....	.....	.....	.....	Commission No. 767.....	179
2	31	.....	.....	.....	.....	Commission No. 762.....	180
2	53	.....	.....	.....	.....	Commission No. 768.....	181
.....	35	.....	.....	.....	.....	Poor water.....	182
36	28	.....	.....	.....	.....	Lignitized wood at 28 feet.....	183
2	86	.....	.....	50	Pleistocene.....	.....	184
.....	60	.....	.....	0	.....	Blue clay, 0–60 feet.....	185
.....	149	.....	.....	0	.....	Fordham gneiss, 110 to 149 feet.....	186
6	112	.....	Flows.	.....	.....	.....	187
6	190	180–190	Flows.	.....	Jameco?.....	Salt water.....	188
6	90	90	0	.....	Jameco.....	Fresh water.....	
.....	30	20–30	−20	Good.	Tisbury.....	.....	189
.....	20–30	.....	.....	.....	.....	.....	190
5	50	.....	.....	.....	Tisbury.....	Abandoned station.....	191
5	200	200	.....	.....	Jameco.....	Brackish water.....	
2	200	200	Flows.	.....	.....do.....	.....	192
8	203	202	Flows.	.....	.....do.....	.....	193
8	180	.....	−10.3	[f]97	.....do.....	Group of 12 wells	[b]194
5	154	146–154	−10.7 −16.7	.....	.....do.....	Brooklyn test well No. 16.....	195
8	170	.....	− 9.6	[f]74	.....do.....	Group of 20 wells	196
8	156–207	117–207	Flows.	15–25	.....do.....	Well No. 15 yielded on test 694 gallons a minute, lowering water to about −14 feet.	[b]
5	271	.....	.....	[d]	.....	Brooklyn test well No. 9.....	197
8	195	.....	+ .8	[f]95	Jameco.....	Group of 12 wells; pumps	[b]198
5	192	185–192	.....	.....	.....do.....	Brooklyn test well No. 18.....	199
2	+100	.....	+ 3	.....	.....do.....	Test well of 1884	
2	28–65	.....	−10.6	18–42	Wisconsin.....	Test of 1894	200
2	44	.....	−11.7	10	.....do.....	Average for 1899	[b]
2	200	140–170	Flows.	Small.	.....	Test well of 1894.....	
4	150	.....	[e]+ 7	90	Jameco.....	Pumps 280 gallons per minute	
6	155	.....	.....	100	.....do.....	Pumps 300 gallons per minute	
6	151	.....	[e]+11	475	.....do.....	Pumps 500 gallons per minute	
10	290	.....	.....	.....	.....	Andrews's well; abandoned	201 [b]
8	151	137–151	Flows.	154	Jameco.....	Pumps 700 gallons.....	
2	23–73	.....	.....	.....	.....	.....	
4–10	160	.....	− 3.4	.....	.....	Group of 207 wells.....	
5	156	141–156	+ 1	.....	Jameco.....	Brooklyn test well No. 1; flows 30 gallons per minute.	202
5	257	146–162	+ 2	.....	.....do.....	Brooklyn test well No. 2; flows 5 gallons per minute.	203

[d] No water was obtained below surface gravel.
[e] Letter from W. D. Andrews & Bro.
[f] Average yield to pumps per well per minute for 1899.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*204	Aqueduct and New York avenue.	4 C.	Department water supply, gas, and electricity.		I. M. De Varona.
*205	Aqueduct and Farmers avenue.	4 C.	do.		do.
*206	Aqueduct.	4 C.	do.		do.
*207	New York avenue near Locust avenue.	4 C.	Commission.		Commission.
*208	Rockaway road.	4 C.	do.		do.
*209		4 C.	do.		do.
*210	Morris Park.	4 C.	do.		do.
*211	Jamaica.	4 C.	do.		do.
*212	do.	4 C.	Department water supply, gas, and electricity.		I. M. De Varona.
*213	do.	4 C.	Jamaica Water Supply Co.		L. B. Ward.
				C. A. Lockwood.	C. A. Lockwood.
*214		4 C.	Commission.		Commission.
*215		4 C.	do.		do.
*216		4 C.	do.		do.
*217		4 C.	do.		do.
*218	Queens.	4 C.	do.		do.
219	Hollis.	4 C.	F. W. Dunton.	C. A. Lockwood.	C. A. Lockwood.
*220	do.	4 C.	Department water supply, gas and electricity.		I. M. De Varona.
*221	Woodhull Park.	4 C.	Commission.		Commission.
*222	West Jamaica.	4 C.	do.		do.
*223	Dunton.	4 C.	Montauk Water Co.		L. B. Ward.
				C. A. Lockwood.	C. A. Lockwood.
*224	Willow Glen.	4 C.	Commission.		Commission.
*225	Head of Flushing Creek.	4 C.	Citizens' Water Supply Co.		L. B. Ward.
*226	Deep Glen Spring.	4 C.	Edgar L. Wakeman.		
*227		4 C.	Commission.		Commission.
*228		4 C.			R. S. Hopkins.
*229		4 C.	Commission.		Commission.
*230	Casino Lake.	4 C.	Casino Lake Ice Co.		Engineer.
				Sweeney & Gray.	Sweeney & Gray.
*231	Fresh Meadow pumping station.	4 C.	Department water supply, gas and electricity		L. B. Ward.
				Chester D. Corwin.	Chester D. Corwin.
				do.	do.
				do.	do.
*232	Flushing.	4 D.	Commission.		Commission.
*233	Broadway.	4 D.	do.		do.

*For additional data see descriptive notes, pp. 168 et seq.
[a] With hand pump from water-bearing stratum between 176 and 182 feet.
[b] Average of whole station for 1899.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Yield per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
5	277	1–82	− 1	.....	Wisconsin and Tisbury.	Brooklyn test well No. 3	204
5	295	6–28	.....	.....	Wisconsin	Brooklyn test well No. 8	205
5	419	20–78 176–182	− 6	[a] 2	Wisconsin, Tisbury, and Jameco.	Brooklyn test well No. 7	206
2	29.5	.....	.....	.....	.....	Commission No. 628	207
2	31	.....	.....	.....	.....	Commission No. 638	208
2	44	.....	.....	.....	.....	Commission No. 467	209
2	50.5	.....	.....	.....	.....	Commission No. 673	210
2	122	.....	.....	.....	.....	Commission No. 426	211
5	197	11–95	−11	Large...	Wisconsin and Tisbury.	Brooklyn test well No. 11	212
		190–198	−11	Large...	Jameco		
10 5	50–60	.....	.....	[b] 1,041	Wisconsin and Tisbury.	Group of 19 wells; Jamaica pumping station.	
96	57	.....	.....	.....	.....	.....	
8	50	.....	.....	.....	.....	Tile well	213 (c)
10	150	.....	.....	.....	Jameco	.....	
5	50	.....	.....	173	.....	.....	
10–4	352	.....	− 1	.....	Cretaceous	Chalybeate water	
2	31	.....	.....	.....	.....	Commission No. 588	214
2	25.5	.....	.....	.....	.....	Commission No. 627	215
2	24.5	.....	.....	.....	.....	Commission No. 639	216
2	32	.....	.....	.....	.....	Commission No. 717	217
2	60	.....	.....	.....	.....	Commission No. 688	218
.....	80	.....	−60	.....	Wisconsin	Reddish brown sand and gravel 0 to 80 feet.	219
5	406	.....	.....	.....	.....	Brooklyn test well No. 6	220
2	29	.....	.....	.....	.....	Commission No. 687	221
2	52	.....	.....	.....	.....	Commission No. 551	222
10	30–50	.....	.....	[d] 61	Wisconsin and Tisbury.	Group of 17 tile wells	223 (c)
10	64	.....	−22	139	.....do	.....	
2	25	.....	.....	.....	.....	Comm ssion No. 1373	224
6	45	.....	Flow.	[d] 46	Wisconsin and Tisbury.	Station No. 3. Group of 31 wells	[c]225
Spring.	.....	.....	.....	347	.....	.....	226
2	46	.....	.....	.....	.....	Commission No. 1374	227
30	86	.....	.....	.....	Tisbury	.....	228
2	35	.....	.....	.....	.....	Commission No. 695	229
8	35	.....	.....	.....	Wisconsin	Pumps 400 gallons per minute	
2	35	.....	Flow.	.....	.....do	.....	230
8	40	35–40	+ 1	.....	.....do	.....	
Springs.	.....	.....	.....	[b] 432	.....do	.....	
2	80	49	+ 2	1.5	Pleistocene	.....	231
2	55	35–40	.....	.....	.....	.....	(c)
2	80	26–55	.....	.....	.....	.....	
2	33	.....	.....	.....	.....	Commission No. 860	232
2	40	.....	.....	.....	.....	Commission No. 1089	233

[c] See Table VIII.
[d] Average yield to pumps per well per minute for 1899.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*234	Corner Queens avenue and Rocky Hill road.	4 D...	Commission		Commission
*235	Auburndale	4 D...	do		do
*236	Bayside	4 D...	do		do
*237	do	4 D...	do		do
*238	Bayside pumping station.	4 D...	Department water supply, gas and electricity.		J. Laughlin, engineer N. S. Hill, chief engineer
*239	Whitestone pumping station No. 1.	4 D...	do		L. B. Ward
*240	Whitestone Landing	4 D...	McWilliams Coal Co	Sweeney & Gray	Sweeney & Gray
*241	do	4 D...	Long Island R. R	Frank Wankel	Frank Wankel
*242	Whitestone pumping station No. 2.	4 D...	Department water supply, gas and electricity.		L. B. Ward
*243	Whitestone	4 D...	W. W. Cole	Stotthoff Bros	Stotthoff Bros.[a]
*244	Willets Point	4 D...	U. S. Army	Daniel Dull	McGinnis, foreman
245	Elm Point; Great Neck	4 D...	Geo. B. Holt		J. H. Herbert
*246	do	4 D...	H. Bramhall Gilbert	J. H. Herbert	do
*247	do	4 D...	Jos. E. Martin	do	do
248	do	4 D...	H. Bramhall Gilbert	do	do
*249	do	4 D...	do	do	do
250	do	4 D...			do
*251	Hewlett Point	4 D...	Harris C. Childs	do	do
*252	do	4 D...	do	do	do
253	do	4 D...	David L. Provost		do
*254	do	4 D...	Chas. L. Griffin	do	do
*255	do	4 D...	Wm. H. Arnold	do	do
*256	do	4 D...	Mrs. Marion E. Scott	Stotthoff Bros	Stotthoff Bros
*257	do	4 D...	do	J. H. Herbert	J. H. Herbert
*258	do	4 D...	Geo. B. Wilson	do	do
*259	Lawrence Beach	5 B...	Lawrence Beach Bathing Association.	Paul Haller	Paul Haller
*260	Isle of Wight	5 B...	John Lawrence	F. K. Walsh	F. K. Walsh
*261	Lawrence	5 B...	Daniel D. Lord	Jesse Conklin	Gilbert Baldwin, foreman
*262	do	5 B...	Anson W. Hart	Paul Haller	Paul Haller
*263	do	5 B...	Edward Man	F. K. Walsh	Edward Man
264	Cedarhurst	5 B...	James Keene	do	F. K. Walsh
*265	do	5 B...	Judge Diver	do	do
*266	do	5 B...	Dr. Wm. B. Anderson	Paul Haller	Paul Haller
*267	do	5 B...	Louis Touscher	do	do
*268	Brower Point	5 B...	Samuel Brower	Gilbert Baldwin	Gilbert Baldwin
269	Woodmere	5 B...	F. K. Walsh	F. K. Walsh	F. K. Walsh
270	do	5 B...	Gilbert Baldwin	Gilbert Baldwin	Gilbert Baldwin
271	do	5 B...	Warren Brower	F. K. Walsh	F. K. Walsh
*272	Hook Creek	5 B...	William C. Baker		

*For additional data see descriptive notes, pp. 168 et seq.
[a] See Table VIII.
[b] Weir measurement.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Yield per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
2	41					Commission No. 1187	234
2	38					Commission No. 1090	235
2	64					Commission No. 1144	236
2	71					Commission No. 1170	237
2½, 3, 4, 6	38–50	38–50	Flow.		Tisbury?	Group of 21 wells. Pumps 43 gallons	238 (a)
Springs				[b] 1,236		Discharge of Oakland Lake.[c]	
4–5	55–75	45–95	Flow.	[d] 6	Jameco	Group of 17 wells	a239
8	175			0			240
	120	85–120			Jameco	Brackish water	241
4–3	80		Flow?			Group of 5 wells. Reserve station	a242
6	96		−60	10	Pleistocene		243
	500					Brackish water from bed rock	244
36–6	93		−55				245
	104	103–104	−38				246
2½	67		−12	+22	Tisbury	Elevation 46 feet above tide	247
4	40		−15	+20	do	All glacial gravel	248
	60			0		Cretaceous below 12 feet	249
	40			0		Very stiff clay 0 to 40 feet	250
2	66	66	−28	75	Cretaceous ?		251
36–6	102						252
5	28		−22	58			253
	68		−42		Cretaceous ?		254
2	159		−40		do		255
8	512			0		Rock 230 to 512 feet	256
	164			0		Abandoned	257
2½	108	93–108		Good		Salt water 40 to 60 feet	258
1½	62				Jameco ?		259
8–2	100	20–30	− 6		Wisconsin and Tisbury.		260
5	100	70–100	− 5	Large	Jameco		261
6	70	60–70	−26		Jameco ?	First water encountered at 16 feet	262
6–3	416	40			Tisbury	Contaminated with sewage	263
		150	−15		Jameco	Chalybeate	
		416	−15		Cretaceous	Salty	
6	30	25–30			Tisbury		264
	35		−20				265
8	42	16–42	−16				266
6	37	16–37	−16				267
5	35	27–35	−18		Tisbury		268
	40	15–40	−15		do	All sand and gravel	269
6	31		−19		do	All sand and gravel. Water chalybeate	270
6	30		−12.5		do	All sand and gravel	271
	228	228	Flow.		Jameco	Slight flow at 150 feet	272

[c] Also called Douglass Pond.
[d] Average per well for 1899. Estimated capacity per well per minute, 33 gallons.
[e] Ann. Rept. Geol. Survey New Jersey for 1899, 1900, p. 132.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*273	Queens County Water Co. pumping station.	5 B...	Queens County Water Co...	.....	Chas. R. Bettes, chief engineer.
*274	Hewlett.....	5 B...	Jirden Abrames.....	F. K. Walsh.....	F. K. Walsh.....
*275	Lynbrook.....	5 B...	Mrs. Julia Flower.....	.....do.....	.....do.....
276	.....do.....	5 B...	T. J. Simpson Co.....	Chas. A. Fass.....	Chas. A. Fass.....
*277	.....do.....	5 B...	Queens County Water Co...	.....	Franklin B. Lord, president.
*278	Brooklyn Aqueduct....	5 B...	Department water supply, gas and electricity.	.....	I. M. De Varona.....
*279	.....do.....	5 B...	.....do.....	.....	.....do.....
*280	.....do.....	5 B...	.....do.....	.....	.....do.....
*281	.....do.....	5 B...	.....do.....	.....	.....do.....
*282	.....do.....	5 B...	.....do.....	.....	.....do.....
*283	Valley Stream.....	5 B...	C. Schreiber.....	Gilbert Baldwin.....	Gilbert Baldwin.....
*284	.....do.....	5 B...	Long Island R. R.....	.....	.....
*285	Brooklyn Aqueduct....	5 B...	Department water supply, gas, and electricity.	.....	I. M. De Varona.....
*286	Watts Pond pumping station.	5 B...	.....do.....	J. Edwards & Co.....	.....do.....
*287	.....do.....	5 B...	.....do.....	.....	.....do.....
*288	Clear Stream pumping station.	5 B...	.....do.....	W. D. Andrews & Bro..	.....do..... L. B. Ward.....
				.....do.....	W. D. Andrews & Bro.....
*289	.....do.....	5 B...	.....do.....	.....	I. M. De Varona.....
*290	Forest Stream pumping station.	5 B...	.....do.....	W. D. Andrews & Bro . .....do.....	.....do..... L. B. Ward..... W. D. Andrews & Bro.....
				Phillips and Worthington.	Phillips and Worthington..
*291	Brooklyn Aqueduct....	5 C...	.....do.....	.....	I. M. De Varona.....
*292	.....do.....	5 C...	.....do.....	.....	.....do.....
*293	.....do.....	5 C...	.....do.....	.....	.....do.....
*294	Rosedale.....	5 C...	Commission.....	.....	Commission.....
*295	Springfield.....	5 C...	Department water supply, gas, and electricity.	.....	I. M. De Varona.....
*296	Fosters Meadows.....	5 C...	Commission.....	.....	Commission.....
*297	1 mile north of Valley Stream.	5 C...	.....do.....	.....	.....do.....
*298	2 miles north of Valley Stream.	5 C...	.....do.....	.....	.....do.....
*299	.....	5 C...	.....do.....	.....	.....do.....
*300	.....	5 C...	.....do.....	.....	.....do.....
*301	.....	5 C...	.....do.....	.....	.....do.....
*302	Elmont.....	5 C...	.....do.....	.....	.....do.....
*303	Floral Park.....	5 C...	.....do.....	.....	.....do.....
*304	.....	5 C...	.....do.....	.....	.....do.....

* For additional data see descriptive notes, pp. 168 et seq.
[a] Maximum daily pumpage for whole station in 1902.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Yield per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
4–5	33	.....	.....	[a] 3,125	Tisbury	.....	273 (b)
6	150–190	.....	Flow.		Jameco	.....	
6	160	.....	Flow.	.....	.....do	Pumps 555 gallons	
5	70	70	−12	.....	.....do	.....	274
.....	180	.....	−13.5	Small.	.....	.....	275
.....	65	.....	.....	0	.....	Clay 47 to 65 feet	276
8	504	.....	+ 2	.....	.....	Pumps 305 gallons per minute	277
6	74	.....	+ 1	.....	.....	.....	
3	14	.....	.....	.....	.....	Flows intermittently	
5	200	.....	.....	0	.....	Brooklyn test well No. 24	278
5	390	.....	.....	0	.....	Brooklyn test well No. 23	279
5	370	.....	.....	Small.	Cretaceous	Brooklyn test well No. 22	280
5	410	300–305	.....	Small.	.....do	Brooklyn test well No. 21	281
5	242	.....	.....	Small.	.....do	Brooklyn test well No. 20	282
1½	18	.....	.....	.....	.....	.....	283
.....	.....	.....	.....	.....	.....	Analysis	284
5	207	.....	Flow.	Small.	Cretaceous ?	Brooklyn test well No. 19	285
6	48–53	.....	−10.3	144	.....	Test of January, 1895; group of 12 wells	[b]286
5	331	.....	.....	.....	.....	Brooklyn test well No. 25	287
2	29–53	.....	.....	[c] 25–53	Wisconsin and Tisbury.	Test of 1894; group of 150 wells	288 (b)
2	38	.....	−11.6	[c]12	.....do	Average for 1899; group of 150 wells	
2	+106	.....	+ 3	10	Jameco (?)	Test well driven in 1884	
5	190	.....	.....	0	.....	Brooklyn test well No. 15	289
2	33–56	.....	.....	22	Wisconsin and Tisbury.	Group of 110 wells	290 (b)
2	.....	.....	− 5	21			
4–2	300	60 100 300	Flows.	5–10	Jameco and Cretaceous.	Test well driven in 1884	
4	400	35	.....	5	.....	Test well driven in 1884; no water below 35 feet.	
4	435	105	.....	.....	.....	.....	
5	406	.....	.....	0	.....	Brooklyn test well No. 12	291
5	412	.....	.....	0	.....	Brooklyn test well No. 13	292
5	390	.....	.....	0	.....	Brooklyn test well No. 14	293
2	30.5	.....	.....	.....	.....	Commission No. 659	294
5	357	.....	.....	0	.....	Brooklyn test well No. 10	295
2	35.5	.....	.....	.....	.....	Commission No. 660	296
2	26	.....	.....	.....	.....	Commission No. 661	297
2	25.5	.....	.....	.....	.....	Commission No. 672	298
2	120.5	.....	.....	.....	.....	Commission No. 1197	299
2	41	.....	.....	.....	.....	Commission No. 606	300
2	25.5	.....	.....	.....	.....	Commission No. 590	301
2	14–34	.....	.....	.....	.....	Commission Nos. 1013–1033, 1146–1154	302
2	41	.....	.....	.....	.....	Commission No. 607	303
2	38	.....	.....	.....	.....	Commission No. 552	304

[b] See Table VIII.

[c] Yield per well.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*305	New Hyde Park	5 C	Commission		Commission
*306	do	5 C	do		do
*307	do	5 C	do		do
*308	do	5 C	do		do
309	do	5 C	Chas. Morgan	Ed. Schmidt	Ed. Schmidt
*310	Floral Park	5 C	Commission		Commission
311	do	5 C	Freestone	Ed. Schmidt	Ed. Schmidt
*312	Creedmoor	5 C	Commission		Commission
313	do	5 C	Anthony Graf		Anthony Graf
314	do	5 C	C. W. Ward	Andrew Vandewater	C. W. Ward
*315	Alley Creek	5 D	Citizens' Water Supply Co		J. Edward Meyer
*316	Douglaston	5 D	Jagnow Bros	J. H. Herbert	J. H. Herbert
*317	Lake Success	5 D	W. K. Vanderbilt, jr	Thos. B. Harper	Thos. B. Harper[a]
*318	do	5 D	Commission		Commission
*319	Lakeville	5 D			Henry Onderdonk, sr
*320		5 D	Commission		Commission
*321	Plattsdale	5 D	Ed. C. Willetts	Ed. Schmidt	Ed. Schmidt
*322	do	5 D	A. Kiefer	Andrew Vandewater	Andrew Vandewater
*323	1 mile south of Manhasset.	5 D	Commission		Commission
*324	Little Neck	5 D	W. J. Hamilton	J. H. Herbert	J. H. Herbert
*325	do	5 D	D. O'Leary	do	do
*326	Thomaston	5 D	Commission		Commission
*327	do	5 D	J. B. Hixon	J. H. Herbert	J. H. Herbert
328	do	5 D		do	do
*329	Thomaston (Great Neck station).	5 D	Long Island R. R. Co	 do Phillips & Worthington	Long Island R. R. Co do Phillips & Worthington
*330	Manhasset	5 D	Commission		Commission
331	do	5 D	Henry Huber		
*332	do	5 D	J. F. Hamilton	J. M. Peler	J. F. Hamilton
333	do	5 D	John H. Rice		
334	do	5 D	Herman Klothe		
*335	do	5 D	J. H. L'Hommedieu's Sons		J. H L'Hommedieu's Sons
336	Manhasset Hill	5 D	Estate of L. A. Seaman		W. A. Skidmore
*337	do	5 D	Commission		Commission
*338	do	5 D	Henry Lustgarten		Henry Lustgarten
339	do	5 D	Christ Church		Chas. Newbold
*340	do	5 D	Commission		Commission
*341	Great Neck	5 D	Great Neck school	Isaac Kasteard	Isaac Kasteard
*342	do	5 D	Mrs. Mary E. King	do	do
343	do	5 D	C. F. Recknagel		J. H. Herbert
*344	do	5 D	H. B. Booth		H. B. Booth
*345	do	5 D	H. B. Anderson		Wm. Mahoney, superintendent.
346	do	5 D	Wm. R. Grace	J. H. Herbert	J. H. Herbert
*347	do	5 D	do	Phillips & Worthington	Phillips & Worthington
*348	do	5 D	V. P. Travis	J. H. Herbert	J. H. Herbert
349	do	5 D		do	do

*For additional data see descriptive notes, pp. 168 et seq.
[a] Through A. S. Farmer, C. E.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Yield per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
2	32.5					Commission No. 553	305
2	56					Commission No. 740	306
2	74					Commission No. 741	307
2	66.5					Commission No. 907	308
1½	37	35–37	− 35			Bowlders, 35 to 37 feet	309
2	106					Commission No. 829	310
1½	40					Coarse white sand, 28 to 40 feet	311
2	56					Commission No. 619	312
33	60	55–60	− 55		Wisconsin		313
48	70	62–70	− 62		do		314
4½	32–42		− 2 + 8	Flow. 0–50		Group of 8 wells; 6 flowing	315
6	127				Tisbury?		316
8–4½	755	191 700–750	−116 −135	40 +300	Cretaceous Lloyd gravel		317
2	35					Commission No. 864	318
36	140						319
2	45					Commission No. 776	320
	37		− 22		Wisconsin	Depends on perched water table	321
36	116		114		Cretaceous?		322
2	48.5					Commission No. 956	323
2½	136				Cretaceous		324
2½	142				do		325
2	79				do	Commission No. 1191	326
2½	93		− 87		do		327
2½	87				do		328
6	96			+ 30		Well 200 feet from station	329
	117	117	[b] − 10	150		2 wells one-fourth mile apart	
6	112	93–112	− 53	100			
2	25					Commission No. 957	330
2	30		Flows.			Elevation 20½ feet	331
2	78		Flows.	½			332
½	37		Flows.				333
½	35		Flows.	2			334
1	10		Flows.				335
34	86	40 80	− 80				336
2	28					Commission No. 1190	337
34–2	122		− 81				338
36	108		−103			Temperature about 50° F	339
2	87.5				Cretaceous	Commission No. 963	340
	52		− 30				341
	52		− 48		Tisbury		342
	96	92				Blue clay 0 to 92 feet	343
	240	−240					344
	237	237					345
	86		− 74			Well is near barn	346
6	104			60	Tisbury		347
2	119		− 77	500	Tisbury?	Surface water at 24 feet	348
	32		− 8	500	Wisconsin	Elevation about 95 feet	349

[b] Pumps down to −40.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*350	.....	5 D...	Robert Cox.....	J. H. Herbert.....	J. H. Herbert .....
*351	Plandome Mills.....	5 D...	Robert Seizer.....	Geo. Schmidt.....	Geo. Schmidt.....
*352	Port Washington.....	5 D...	Chas. Vanderbilt.....	Isaac Kasteard.....	Isaac Kasteard.....
353	.....do.....	5 D...	J. Reed.....	.....do.....	.....do.....
*354	.....do.....	5 D...	Commission.....	.....	Commission.....
355	.....do.....	5 D...	Howard Place.....	Isaac Kasteard.....	Isaac Kasteard.....
356	.....do.....	5 D...	Stephen Kimmerly.....	.....do.....	.....do.....
*357	.....do.....	5 D...	Theo. Valentine.....	.....do.....	.....do.....
*358	.....do.....	5 D...	N. H. Jacobs.....	.....do.....	.....do.....
359	.....do.....	5 D...	Lorenzo Smull.....	.....	Lorenzo Smull.....
*360	.....do.....	5 D...	Thos. E. Webb.....	Geo. Schmidt.....	Thos. E. Webb.....
*361	.....do.....	5 D...	Isaac Kasteard.....	Isaac Kasteard.....	Isaac Kasteard.....
*362	.....do.....	5 D...	Long Island R. R.....	.....	Long Island R. R.....
*363	.....do.....	5 E...	Frank Vanoski.....	Isaac Kasteard.....	Isaac Kasteard.....
*364	.....do.....	5 E...	Chas. H. Mason.....	.....	Lorenzo Smull.....
*365	.....do.....	5 E...	Catholic church.....	Isaac Kasteard.....	Isaac Kasteard.....
*366	.....do.....	5 E...	Dodge estate.....	.....do.....	.....do.....
367	Barker Point.....	5 E...	W. De Forest Wright.....	.....	Oscar Darling, consulting engineer.
*368	Sands Point.....	5 E...	Geo. Zabriskie.....	Geo. Schmidt.....	Geo. Schmidt.....
*369	Castle Gould.....	5 E...	Howard Gould.....	Isaac Kasteard.....	Isaac Kasteard.....
*370	.....do.....	5 E...	.....do.....	C. H. Danis.....	C. H. Danis.....
*371	.....do.....	5 E...	.....do.....	Hudson Engineering and Contracting Co.	J. D. Kilpatrick [a].....
*372	.....	5 E...	Bourke Cockran.....	C. H. Danis.....	C. H. Danis.....
*373	Long Beach.....	6 B...	Long Beach Association....	Wm. C. Jaegle.....	Wm. C. Jaegle.....
*374	Barnum Island.....	6 B...	Hempstead Poor House....	Theo. A. Carmen.....	E. Lewis, jr., Theo. Carmen.
*375	East Rockaway.....	6 B...	Long Beach Association....	.....	.....
*375A	.....do.....	6 B...	J. H. Clark.....	Chas. A. Fass.....	Chas. A. Fass.....
*376	Rockville Center.....	6 B...	J. M. Smith.....	E. E. McCarten.....	E. E. McCarten.....
*377	Smith Pond.....	6 B...	Department water supply, gas and electricity.	.....	I. M. De Varona .....
*378	Rockville Center.....	6 B...	Commission.....	.....	Commission.....
*379	.....do.....	6 B...	Rockville Center waterworks.	F. K. Walsh.....	Village clerk.....
*380	.....do.....	6 B...	Commission.....	.....	Commission.....
*381	Millburn Reservoir....	6 B...	.....do.....	.....	.....do.....
*382	.....do.....	6 B...	.....do.....	.....	.....do.....
*383	.....do.....	6 B...	.....do.....	.....	.....do.....
*384	.....do.....	6 B...	.....do.....	.....	.....do.....
*385	.....do.....	6 B...	.....do.....	.....	.....do.....
*386	.....do.....	6 B...	.....do.....	.....	.....do.....
*387	.....do.....	6 B...	.....do.....	.....	.....do.....
*388	.....do.....	6 B...	.....do.....	.....	.....do.....
*389	.....do.....	6 B...	.....do.....	.....	.....do.....
*390	.....do.....	6 B...	.....do.....	.....	.....do.....
*391	.....do.....	6 B...	.....do.....	.....	.....do.....
*392	.....do.....	6 B...	.....do.....	.....	.....do.....

* For additional data see descriptive notes, pp. 168 et seq.
[a] Superintendent for Hudson Engineering and Contracting Co.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Yield per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
.....	107	.....	.....	.....	Cretaceous	.....	350
3	113	21 100-113	− 17 − 80	166	Jameco?	.....	351
32	80	.....	− 76	.....	.....	.....	352
32	76	.....	− 72	.....	Tisbury	Sand 0 to 76 feet	353
2	87	.....	.....	.....	.....	Commission No. 1143	354
32	69	.....	− 65	.....	.....	Sand 2 to 69 feet	355
32	46	.....	− 42	.....	.....	White and yellow sand 0 to 46 feet	356
32	129	.....	−125	.....	.....	.....	357
32	35	.....	− 31	.....	.....	.....	358
3	55	.....	− 41	+12	Tisbury?	White sand and gravel 42 to 55 feet	359
4	206.5	205.6	− 71	Small.	Cretaceous	.....	360
32	69	.....	− 65	.....	.....	.....	361
.....	60–70	.....	.....	.....	.....	.....	362
32	46	.....	− 42	.....	Cretaceous?	.....	363
30–6	83	.....	− 50	Large.	.....	.....	364
32	54	.....	− 50	.....	Tisbury	.....	365
.....	91	.....	.....	Small.	.....	.....	366
3	30	.....	− 20	.....	.....	"Coarse sandy gravel, with water of great purity."	367
6	250	.....	.....	.....	.....	Rock at 250 feet	368
32	88	.....	− 84	.....	.....	.....	369
.6	65	.....	− 20	Large.	Tisbury	2 wells	370
6–4	300	.....	− 20	.....	Cretaceous	Abandoned	370
.....	169	.....	.....	30	.....do	.....	371
.....	120	.....	.....	102	.....do	.....	371
.....	354	.....	Flows.	Small.	.....do	Pipe clogs with quicksand	372
6	386	220 270 340 383	+ 6	5	.....do	Water chalybeate	373
.....	383	123	.....	.....	Jameco	Well abandoned	374
.....	.....	Shallow.	.....	.....	.....	Pumping station for Long Beach	[b]375
4	27	.....	.....	.....	Tisbury	.....	375A
.....	18	.....	− 17	.....	.....do	.....	376
5	587	40–45 578–587	Flows.	5	Cretaceous	Brooklyn test well No. 26	377
2	74	.....	.....	.....	.....	Commission No. 605	378
8	40–50	.....	− 8	[c]26	Tisbury	Group of 4 wells	[b]379
2	24	.....	.....	.....	.....	Commission No. 844	380
2	38	.....	.....	.....	.....	Commission No. 697	381
2	97	.....	.....	.....	.....	Commission No. 658	382
2	31	.....	.....	.....	.....	Commission No. 641	383
2	32	.....	.....	.....	.....	Commission No. 640	384
2	31	.....	.....	.....	.....	Commission No. 630	385
2	25.5	.....	.....	.....	.....	Commission No. 615	386
2	25.6	.....	.....	.....	.....	Commission No. 629	387
2	25	.....	.....	.....	.....	Commission No. 616	388
2	25.5	.....	.....	.....	.....	Commission No. 623	389
2	29.8	.....	.....	.....	.....	Commission No. 617	390
2	32.3	.....	.....	.....	.....	Commission No. 618	391
2	31.7	.....	.....	.....	.....	Commission No. 622	392

[b] See Table VIII.

[c] Average for 1903.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*393	Baldwin	6 B	M. S. Thomas	W. J. Hancock	W. J. Hancock
*394	do	6 B	C. H. Southard	H. Wortman	H. Wortman
*395	do	6 B	H. Wortman	do	do
*396	do	6 B	Adolph Schreiber		A. Schreiber
397	Freeport	6 B	Freeport waterworks		Engineer
398	Hempstead reservoir	6 C		Theo. Carmen	Theo. Carmen
*399	Norwood	6 C	Commission		Commission
*400		6 C	do		do
*401		6 C	do		do
*402	Greenwich Point	6 C	do		do
*403	Hempstead	6 C	do		do
*404	do	6 C	do		do
405	do	6 C	Hempstead Water Co		Engineer
*406	do	6 C	Commission		Commission
*407	East Meadow Brook	6 C	do		do
*408		6 C	do		do
*409	Garden City	6 C	do		do
*410	do	6 C	do		do
*411	do	6 C	do		do
412	do	6 C	St. Paul School	Andrew Vandewater	Andrew Vandewater
*413	do	6 C	Commission		Commission
*414	do	6 C	Garden City Water Supply Co.		Geo. L. Hubbell, general manager.
415	Mineola	6 C	Court-house	C. A. Lockwood	C. A. Lockwood
*416	do	6 C	Commission		Commission
417	do	6 C	Long Island R. R. Co	C. A. Lockwood	C. A. Lockwood
*418	do	6 C	Commission		Commission
*419	do	6 D	do		do
*420	East Williston	6 D	Chas. Edison	Geo. Schmidt	Geo. Schmidt
*421	do	6 D	Commission		Commission
*422	Albertson	6 D	do		do
*423	Old Westbury	6 D	W. G. Parks		
*424	do	6 D	W. P. Kelsey	John Fisher	John Fisher
*425	do	6 D	Jas. F. Brady	Wm. Jaegle	Wm. Jaegle
*426	do	6 D	R. L. Cottnet	Alfred Wisson	Alfred Wisson
*427	do	6 D	J. F. D. Lanier		Long Island Historical Society.
*428	do	6 D	John A. Albertson	Alfred Wisson	Alfred Wisson
*429	do	6 D	Foxhall Keene		
*430	do	6 D	H. B. Duryea	Hudson Engineering and Contracting Co.	John Tart[a]
				John Fisher	John Fisher
				A. J. Connolly	
				Alfred Wisson	Alfred Wisson
*431	Wheatley Hills	6 D	E. D. Morgan		E. D. Morgan
				A. W. Gallienne	Ed. Danis[b]
				Hudson Engineering and Contracting Co.	F. Wankel[a]

*For additional data see descriptive notes, pp. 168 et seq.
[a] Foreman for Hudson Engineering and Contracting Co.
[b] Drilling the Harriman well (512) at the time this well was sunk.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Yield per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
.....	18	.....	.....	.....	.....	Average of all wells about Baldwin.....	393
4	35	.....	.....	.....	.....	.....	394
.....	50	.....	.....	.....	.....	Very black mud at 50 feet.....	395
8	370	.....	+ 1	.....	Cretaceous.....	.....	396
6 and 10	35	.....	− 10	40	Tisbury.....	4 wells.....	[c]397
.....	360	.....	Flows.	10	Cretaceous.....	.....	398
2	34	.....	.....	.....	.....	Commission No. 825.....	399
2	32	.....	.....	.....	.....	Commission No. 845.....	400
2	32	.....	.....	.....	.....	Commission No. 846.....	401
2	30	.....	.....	.....	.....	Commission No. 604.....	402
2	33.5	.....	.....	.....	.....	Commission No. 847.....	403
2	97	.....	.....	.....	.....	Commission No. 848.....	404
.....	50	.....	− 15	10	Wisconsin and Tisbury.	Group of 8 wells.....	[a]405
2	52.7	.....	.....	.....	.....	Commission No. 425.....	406
2	125	.....	.....	.....	.....	Commission No. 424.....	407
2	35	.....	.....	.....	.....	Commission No. 423.....	408
2	37	.....	.....	.....	.....	Commission No. 422.....	409
2	37	.....	.....	.....	.....	Commission No. 862.....	410
2	25	.....	.....	.....	.....	Commission No. 591.....	411
120	40	.....	− 30	Large.	Wisconsin and Tisbury.	.....	412
2	38.5	.....	.....	.....	.....	Commission No. 589.....	413
600	40	.....	− 19	.....	.....	See Table VIII	414
.....	80	.....	− 60	.....	.....	Reddish sand and gravel 0 to 80 feet.....	415
2	42.5	.....	.....	.....	.....	Commission No. 863.....	416
10	90	30-90	− 30	.....	Wisconsin and Tisbury.	Sand and gravel 0 to 90 feet.....	417
2	56	.....	.....	.....	.....	Commission No. 901.....	418
2	53.5	.....	.....	.....	.....	Commission No. 587.....	419
36	56.5	50-56	− 50	.....	Tisbury.....	.....	420
2	55	.....	.....	.....	.....	Commission No. 906.....	421
2	37	.....	.....	.....	.....	Commission No. 959.....	422
.....	230	.....	−100	.....	Cretaceous?.....	Incomplete.....	423
.....	150	.....	−100	.....	Cretaceous.....	.....	424
6	143	.....	− 73	.....	.....	.....	425
6	180	.....	−110	+30	Cretaceous.....	.....	426
.....	103	.....	.....	.....	.....	.....	427
5	150	.....	−146	25	Cretaceous ?.....	.....	428
.....	383	.....	.....	.....	Cretaceous.....	.....	429
6	343	.....	−117	110	.....do.....	.....	430
.....	298	.....	−274	.....	.....	.....	
.....	280	.....	.....	.....	.....	.....	
8	280	.....	−250	.....	.....	.....	
8	284	.....	−244	8	Cretaceous.....	Well completed in 1896.....	431
.....	283	.....	.....	.....	.....	.....	
8	434	.....	−245	150	.....	.....	

[c] See Table VIII.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*432	Wheatley Hills	6 D...	Wm. C. Whitney		Wm. C. Whitney
*433	do	6 D...	do		Thos. Griffin [a]
*434	do	6 D...	Stanley Mortimer	Alfred Wisson John Fisher	Alfred Wisson John Fisher
*435	do	6 D...	W. Stowe	I. H. Ford John Heerdegan	I. H. Ford John Heerdegan
*436	Roslyn	6 D...	Mrs. I. Vowman	George Schmidt	George Schmidt
*437	do	6 D...	Nassau Electric Light and Power Co.	John Heerdegan	John Heerdegan
*438	do	6 D...	Theo. Valentine	Ed. Schmidt	Ed. Schmidt
439	do	6 D...		C. H. Danis	C. H. Danis
*440	do	6 D...	Commission		
*441	do	6 D...	do		
442	do	6 D...	C. H. Mackay		
443	do	6 D...	L. F. Powell	L. J. Dubois	L. J. Dubois
*444	do	6 D...	Walter Willetts	Jesse Conklin	A. J. Corcoran [c]
*445	Glenwood Landing	6 D...	Ward J. Post brickyard	George Schmidt	George Schmidt
*446	Glenhead	6 D...	A. A. Knowles	L. J. Dubois	L. J. Dubois
447	Greenvale	6 D...	Frank Nostrand	do	do
448	Hempstead Harbor	6 E...	J. B. King & Co		J. B. King & Co
449	Sea Cliff	6 E...			L. J. Dubois
*450	do	6 E...	—— Kersona	L. J. Dubois	do
451	do	6 E...	F. W. Geissenhainer	do	do
*452	do	6 E...	Sea Cliff Water Co		J. T. Pirie, president
*453	Glenhead	6 E...	Thos. C. Watt	L. J. Dubois	L. J. Dubois
*454		6 E...	Commission		Commission
*455	Glen Cove	6 E...	Nassau County Water Co		W. F. Clapton, superintendent.
*456	Locust Valley	6 E...	Friends' Academy	L. J. Dubois	L. J. Dubois
*457	Glen Cove	6 E...	F. E. Willets	do	do
*458	do	6 E...	S. Seeman	do	do
*459	do	6 E...	S. Burke	do	do
*460	do	6 E...	North Country Club	C. H. Danis	C. H. Danis
461	do	6 E...	Frank Bernheim		L. J. Dubois
*462	do	6 E...	John Minniken	L. J. Dubois	do
*463	do	6 E...	Crystal Springs Ice Co	do	do
*464	Glen Cove Landing	6 E...	J. P. Tangeman	Phillips & Worthington	Phillips & Worthington
*465	Dosoris	6 E...	Wm. M. Valentine	L. J. Dubois	L. J. Dubois
*466	do	6 E...	Pratt estate		D. M. Munger, superintendent.
*467	do	6 E...	do		do
468	Dosoris Island	6 E...	Paul Dana	L. J. Dubois	L. J. Dubois

*For additional data see descriptive notes, pp. 168 et seq.
[a] Superintendent for W. C. Whitney.
[b] See Table VIII.
[c] Windmill manufacturer, 11 John street, New York.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Yield per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
10	400	.....	−230	35	Cretaceous.....	Water soft.....	432
.....	340	.....	.....	4–5	.....do.....	.....	433
8	300	.....	.....	50	.....do.....	.....	434
.....	205	.....	.....	Large.	.....	Water in gravel.....	
.....	389	.....	.....	.....	.....	Very little water.....	435
8	265	.....	−218	17	Cretaceous.....	.....	
6	115	.....	− 96	Good.	Pleistocene.....	.....	436
8	250	.....	− 78	83 49 16 42	Cretaceous.....	Group of 4 wells.....	437
32	128	.....	.....	.....	Pleistocene ?.....	.....	438
6	300–400	.....	− 70	.....	.....	Abandoned.....	439
2	52	.....	.....	.....	Pleistocene.....	Commission No. 1199.....	440
2	25	.....	Flows.	.....	.....do.....	Commission No. 1185. Slight flow.....	441
.....	.....	.....	.....	.....	.....	Private pumping plant. Shallow wells.....	[b]442
3	82.5	.....	− 70	18	.....	.....	443
6	190	.....	− 50	.....	.....	.....	444
3	69	69	− 22	50	.....	.....	445
2	141	.....	−122	12	Cretaceous.....	.....	446
2	96	.....	− 66	.....	.....	All sand.....	447
6	98	.....	Flows.	.....	.....	Flows into pit 2 feet above tide level.....	448
.....	Shallow.	.....	Flows.	.....	.....	.....	449
2	106	45	Flows.	Small.	.....	Abandoned.....	450
2	32	.....	− 23	+25	Pleistocene.....	All sand and gravel.....	451
6	60	.....	([d])	.....	.....	Group of 6 wells. Pumps 70 gallons [e].....	[b]452
3	140	.....	−122	.....	.....	.....	453
2	52	.....	.....	.....	Tisbury.....	Commission No. 960.....	454
10	45–60	34–60	Flows.	.....	.....do.....	Group of 4 wells. Pumps 315 gallons per well per minute.	455
4	40	34–40	Flows.	.....	.....do.....	Flows 18 gallons per minute.....	([b])
3½	222	212–222	− 75	30	Cretaceous.....	.....	456
3	186	182–186	−108	16	Cretaceous ?.....	.....	457
2	140	.....	− 98	12	.....do.....	.....	458
2	170	165–170	− 98	12	Cretaceous.....	.....	459
4	109 129	.....	.....	.....	.....	.....	460
6	130	.....	Flows.	.....	Cretaceous ?.....	Small flow.....	461
2	80	78–80	Flows.	.....	Cretaceous.....	.....	462
2 4	73 72	70–73	+ 14	[f] 18 [f] 30	.....do.....	.....	463
4	106	90–100	− 40	30	.....	.....	464
2	215	79–83	− 65	.....	.....	.....	465
6	38	.....	[g] Flows.	.....	.....	.....	
6	48	.....	.....	.....	.....	.....	
6	38	.....	.....	Large.	Cretaceous?.....	.....	466
6	82	75–82	Flows.	.....	.....	.....	([b])
1½	125	.....	.....	0	.....	4 wells; abandoned.....	
1½	125	.....	.....	0	.....	2 wells; abandoned.....	467
.....	44	.....	− 8	.....	Tisbury.....	All sand and gravel.....	468

[d] Originally all were flowing wells.
[e] Yield per well per minute on a 10-hour test.
[f] Natural flow at ground level.
[g] Since pumping these wells have ceased to flow.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*469	Dosoris Pond	6 E...	D. F. Bush	L. J. Dubois	L. J. Dubois
*470	Peacock Point	6 E...	C. O. Gates	P. H. & J. Conlan	M. Tallon[a]
*471	do	6 E...	do	E. K. Hutchinson	E. K. Hutchinson
*472	do	6 E...	do	C. H. Danis	C. H. Danis
*473	Lattingtown	6 E...	W. D. Gutherie	E. K. Hutchinson	Foreman for E. K. Hutchinson.
*474	do	6 E...	do	L. J. Dubois	L. J. Dubois
*475	do	6 E...	Wm. Price	do	do
*476	do	6 E...	W. H. Baldwin, jr.	do	W. H. Baldwin, jr.
477	do	6 E...	—— Berger	E. K. Hutchinson	E. K. Hutchinson
478	do	6 E...	A. C. Bedford	C. H. Danis	C. H. Danis
*479	do	6 E...	L. C. Wier	do	Ed. Danis, foreman
*480	do	6 E...	do	Phillips & Worthington	Phillips & Worthington
*481	do	6 E...	do	C. H. Danis	Ed. Danis, foreman
*482	do	6 E...	Paul D. Cravath	do	do
*483	do	6 E...	Ed. Latting	do	do
*484	do	6 E...	W. D. Gutherie	do	do
*485	do	6 E...	do	do	C. H. Danis
486	Freeport	7 B...			C. S. Slichter
*487	Agawam pumping station.	7 B...	Department water supply, gas, and electricity.		I. M. De Varona[b] L. B. Ward
*488	Old Freeport pumping station	7 B...	do		I. M. De Varona[g]
*489	Merrick pumping station.	7 B...	do		I. M. De Varona[h] L. B. Ward
*490	Merrick	7 B...	Merrick Water Co		E. C. Cammann, secretary
*491	Matowa pumping station.	7 B...	Department water supply, gas, and electricity.		I. M. De Varona L. B. Ward
*492	do	7 B...	Commission		Commission
*493	Wantagh pumping station.	7 C....	Department water supply, gas, and electricity.		I. M. De Varona L. B. Ward
*494	do	7 C....	Commission		Commission
*495	Wantagh	7 C....	do		do
*496	do	7 C....	do		do
*497	do	7 C....	do		do
*498	Camp meeting grounds	7 C....	do		do
499	Smithville South	7 C....	do		do
*500	Hempstead Plains	7 C?...	U. S. Army Camp Black	Dollard Bros	Dollard Bros

* For additional data see descriptive notes, pp. 168 et seq.
[a] Foreman for P. H. & J. Conlan.
[b] Ann. Rept. Dept. of City Works, Brooklyn, 1896, p. 263, 1897.
[c] Average of whole station, June 17, 1896, to Dec. 31, 1896.
[d] Samples show depth of 110 feet.
[e] Average of whole station for 1899.
[f] See Table VIII.
[g] History and Description of the Water Supply of Brooklyn, 1896, p. 78.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Supply per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
3	97	95–97	+ 6	.....	Jameco?	Flows 30 gallons per minute	469
6	230	230	Flows.	30	Lloyd sand		470
6	225	225	Flows.	5	.....do		471
.....	210	.....	Flows.	.....	.....do		472
6	342	260–342	Flows.	10	.....do		473
2	92	13 25	+ 2 + 2.5	.....	Pleistocene	Test wells	474
2	162	162	− 90	+12	Cretaceous		475
2½	265	260–265	−125	+10	.....do		476
2½	110	.....	− 94	.....	.....	Reported as all sand and gravel	477
.....	148	.....	−110	25	.....		478
.....	132	.....	−114	+25	.....		479
6	123.5	.....	− 93.5	+40	.....		480
6	91.9	.....	− 76	+25	Pleistocene ?		481
4	105	.....	− 80	.....	.....		482
4	138	.....	.....	.....	.....		483
3	108	.....	− 70	.....	.....		484
3	144	.....	− 60	+25	.....	Group of 3 wells	485
.....	60	.....	Flows.	.....	.....		486
.....	.....	.....	.....	[c] 3,131	Pleistocene		487
6	[d] 33–91	.....	.....	[e] 361	Tisbury; Jameco ?	Group of 32 wells	(S)
4½–6	37	.....	.....	.....	Pleistocene	Group of 40 wells; abandoned because of excess of chlorine	488
4½–6	45 106–109	.....	.....	[f] 3,259	Tisbury; Jameco ?	Group of 62 wells	489
4½	40–110	.....	.....	[e] 378	.....	.....do	(S)
.....	30–40	.....	− 4 − 8	5	Pleistocene	Group of 8 wells	490
.....	83	6–35	.....	.....	.....	No water below 40 feet	(S)
.....	.....	.....	.....	[g] 3,122	.....	Formérly called Newbridge	491
4½	38–97	.....	− 6 [k] Flow.	[e] 618	Tisbury Jameco ?	Group of 46 wells	(S)
2	20	.....	.....	.....	.....	Commission No. 1161. Slichter underflow station No. 3.	492
.....	.....	.....	.....	[f] 2,777	.....		493
4½–6	24–92	.....	− 2.7 [k] Flow.	.....	Tisbury Jameco ?	Group of 49 wells	(S)
2	20	.....	.....	.....	.....	Slichter underflow station No. 2, commission No. 1176.	494
2	71	.....	[m] Flows.	.....	.....	Commission No. 1272. Slichter underflow station No. 2.	495
2	83	.....	[m] Flows.	.....	.....	Commission No. 1293. Slichter underflow station No. 15.	496
2	13	.....	.....	.....	.....	Commission No. 1356	497
2	17	.....	.....	.....	.....	Commission No. 1357	498
2	14	.....	.....	.....	.....	Commission No 1375	499
.....	22	.....	− 17	.....	Pleistocene ?		500

[h] Ann Rept. Dept. of City Works, Brooklyn, 1896, p. 266. 1897; History and Description of the Water Supply of Brooklyn, 1896, p 79

[i] Average of whole station, Jan. 23, 1896, to Dec. 31, 1896.

[j] Average of whole station, Sept. 23, 1896, to Dec. 31, 1896

[k] Deep wells only

[l] Average of whole station from July 16, 1896, to Dec. 31, 1896.

[m] Flow began at 62 feet.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*501	Hicksville	7 D	Commission		Commission
*502	do	7 D	do		do
*503	do	7 D	Nassau County Water Co		Oscar Darling, consulting engineer.
504	do	7 D	Fassbender & Stande	W. C. Jaegle	Fassbender & Stande
*505	do	7 D	H. J. Heinz Co	do	W. C. Jaegle
*506	do	7 D	Commission		Commission
*507	do	7 D	Joseph Steinart	W. C. Jaegle	Joseph Steinart
*508	do	7 D	St. John's Protectory	do F. K. Walsh	St. John's Protectory F. K. Walsh
*509	Westbury	7 D	Colored Children's Home	Ed. Schmidt	Ed. Schmidt
510	Old Westbury	7 D	Robert Winthrop		Robert Winthrop
*511	do	7 D	Wm. Payne Thompson	Hudson Engineering and Contracting Co.	G. H. Pease, foreman
*512	Wheatley Hills	7 D	J. H. Harriman	C. H. Danis	Ed. Danis, foreman
*513	Jericho	7 D	Commission		Commission
*514	do	7 D	H. R. Winthrop	Hudson Engineering and Contracting Co.	Thos. Shay, foreman
*515	do	7 D	Theo. Willis	Geo. Schmidt	Geo. Schmidt
*516	do	7 D	Jacob Jackson	W. C. Jaegle	W. C. Jaegle
*517	do	7 D	Jules Kunz	J. W. Hendrickson	Long Island Historical Society.
*518	Syosset	7 D	Allard & McGuire	W. C. Jaegle	W. C. Jaegle
*519	do	7 D	John Kennedy	do	do
*520	Brookville	7 D	County poor farm	E. K. Hutchinson	C. A. Zanor, foreman
*521	do	7 D	Henry Rushmore		J. L. Bogart
*522	East Norwich	7 E	Commission		Commission
*523	do	7 E	—— Quinan	C. H. Danis	C. H. Danis
*524	do	7 E	—— Ludlum	do	do
*525	Oyster Bay	7 E	Nassau County Water Co		Oscar Darling, consulting engineer.
*526	do	7 E	Townsend Underhill	E. K. Hutchinson	A. S. Hutchinson [b]
*527	do	7 E	Charles Weeks	do	do
*528	do	7 E	John M. Sammis	do	The Long Islander [c]
*529	do	7 E	Van Sise & Co	do	A. S. Hutchinson [b]
*530	do	7 E	D. W. Smith	do	do
*531	do	7 E	A. S. Hutchinson	do	do
*532	do	7 E	E. K. Hutchinson	do	do
*533	do	7 E	Townsend heirs	do	do
*534	do	7 E	Jas. Norton	do	do
*535	do	7 E	Capt. Alfred Ludlum	do	do
536	do	7 E	Mrs. Coles White	do	do
537	do	7 E	John M. Sammis		E. M. Sammis [b]
538	do	7 E	Peter N. Layton		Peter N. Layton [b]
*539	do	7 E	A. J. & A. S. Hutchinson	E. K. Hutchinson	A. S. Hutchinson [b]
540	do	7 E	Oysterman's Dock Co	do	do
541	do	7 E	Long Island R. R.		Engineer [b]
*542	do	7 E	Dr. O. L. Jones	E. K. Hutchinson	A. S. Hutchinson [b]
*543	do	7 E	do		R. F. Nichols, foreman

*For additional data see descriptive notes, pp. 168 et seq.
[a] See Table VIII.
[b] Records transmitted to the Survey by Mr. W. H. C. Pynchon, civil engineer and geologist, Oyster Bay, N. Y.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Supply per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
2	56	.....	.....	.....	.....	Commission No. 909	501
2	135.5	.....	.....	.....	.....	Commission No. 955	502
8	85	63–85	− 63	.....	Tisbury	2 wells	a503
6	79	.....	− 71	Large.	Tisbury?	.....	504
42–4	90	.....	− 68	4	Cretaceous	.....	505
2	80.5	.....	.....	.....	.....	Commission No. 1142	506
6	150	130–150	− 75	.....	.....	.....	507
6	73	.....	− 61	35	.....	.....	508
6	80	.....	− 60	.....	.....	.....	
36	60	.....	− 35	Small.	.....	.....	509
10	377	.....	−200	25	Cretaceous	Water slightly hard	510
.....	209	195–205	.....	60	.....do	.....	511
.....	220	200–220	−180	+25	.....do	.....	512
2	60	.....	.....	.....	.....	Commission No. 1193	513
3	183	150–183	−150	.....	Cretaceous	.....	514
6	175	.....	−160	.....	Cretaceous ?	.....	551
36–3	168	.....	−165	.....	.....	Originally reported 210 feet deep	516
36	147.5	.....	.....	.....	.....	.....	517
.....	53	47–50	.....	Large.	.....	.....	518
.....	+150	.....	.....	.....	.....	Well "blows" at a depth of 150 feet	519
.....	278	.....	−105	.....	.....	.....	520
.....	396	.....	.....	0	.....	.....	521
2	23	.....	.....	.....	.....	Commission No. 1192	522
3	224	.....	.....	.....	.....	.....	523
3	149	.....	−213	.....	.....	.....	524
1½	160	4–10	.....	.....	.....	Abandoned	525
4	35	10–30	0	.....	.....	Group of wells	(a)
3	165	162	+ 13	c d 100	Jameco?	.....	526
2	110	90–110	Flows.	c 20	.....do	.....	527
2	140	.....	Flows.	.....	.....	Snouder's pharmacy	528
2	56	53–57	+ 1.5	c 3	Jameco?	Original flow 9 gallons	529
2	65	.....	Flows.	c 5	.....do	Original flow 15 gallons	530
2	90–100	.....	+ 6	c 8.5	.....do	.....do	531
2	83	.....	.....	c f 21	.....do	.....	532
2	133	.....	Flows.	c f 15	.....do	.....	533
2	65–70	.....	.....	c 4	.....do	Original flow 10 gallons	534
2	82	.....	+ 2.3	c 2	.....do	Original flow 9 to 10 gallons	535
3	118	.....	+ 7	c 30	.....do	Original flow 36 gallons	
2	115	.....	+ 1.5	c 7.5	.....do	.....	536
3	60	.....	+ 2	c 5.5	.....do	.....	537
1½	48	.....	+ .5	c 1	.....do	Ceases to flow at low tide	538
5	190	185	+ 17	c 70	.....do	.....	539
2	36	.....	Flows.	4–5	.....	Does not flow at low tide	540
4	20	.....	− 10	+66	.....	.....	541
2	126	.....	+ 9	18	Jameco?	.....	542
4	220	.....	.....	g 26.5	.....do	.....	543

c Rate of flow varies with the tide.
d Flow at ground level. At +17 feet furnishes 5 gallons per minute.
e Huntington, N.Y., June 15, 1895.
f Initial flow.
g Flow at low tide July 30, 1903.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*544	Oyster Bay	7 E	Mohannes Casino	E. K. Hutchinson	A. S. Hutchinson [a]
*545	do	7 E	Townsend Underhill	do	do
*546	do	7 E	—— Lee		R. F. Nichols
*547	do	7 E	—— Burgess		I. Bowman
*548	do	7 E	—— Hamilton	E. K. Hutchinson	E. K. Hutchinson
*549	do	7 E	Wm. Trotter	do	do
550	do	7 E	E. M. Townsend	do	A. S. Hutchinson
*551	do	7 E	Henry Dollard	H. J. Dubois	H. J. Dubois
*552	do	7 E	Edward Swan	Ed. Schmidt H. J. Dubois	Ed. Schmidt H. J. Dubois
*553	do	7 E	E. Roosevelt	E. K. Hutchinson	R. F. Nichols, foreman
*554	Center Island	7 E	G. C. MacKenzie	P. H. & J. Conlan	G. M. Fletcher
*555	do	7 E	G. M. Fletcher	E. K. Hutchinson	do
*556	do	7 E	C. S. Sherman	do	E. K. Hutchinson
*557	do	7 E	S. T. Shaw	do	G. M. Fletcher
*558	do	7 E	Colgate Hoyt	do	E. K. Hutchinson
*559	do	7 E	C. W. Wetmore	do	do
*560	Bayville	7 E	Dr. O. L. Jones	R. F. Nichols	R. F. Nichols
561	do	7 E	Mrs. Elizabeth Godfrey	George Schmidt	Walter Dudley
*562	do	7 E	Winslow Pierce	E. K. Hutchinson	A. Neilson, superintendent.
563	do	7 E	Edward Knierum	George Schmidt	Edward Knierum
*564	Mill Neck	7 E	Irving Cox	C. H. Danis	C. H. Danis
565	Massapequa	8 B	Massapequa Hotel	J. Elliott	J. Elliott
*566	Massapequa pumping station.	8 C	Commission		Commission
*567	do	8 C	Department water supply, gas, and electricity.		I. M. De Varona L. B. Ward
*568	Amityville	8 C	Amityville Water Co		S. Ketchem, secretary
*569	Massapequa	8 C	Commission		Commission
*570	do	8 C	do		do
*571	do	8 C	do		do
*572	do	8 C	do		do
*573	do	8 C	do		do
*574	do	8 C	do		do
*575	do	8 C	do		do
*576	Central Park	8 C	Dryfuss & Nibbe	W. C. Jaegle	W. C. Jaegle
*577	Farmingdale	8 C	Village of Farmingdale	J. Elliott	J. Elliott
*578	do	8 C	J. Keller & Sons	do	do
579	do	8 C	Nassau County Water Co		
*580	do	8 C	Commission		Commission
581	do	8 D	W. Smith	J. Elliott	J. Elliott
*582	Plainview	8 D	Chas. Keil	J. H. Gutheil	J. H. Gutheil
*583	do	8 D	Harms estate	W. C. Jaegle	W. C. Jaegle
*584	do	8 D	John Titus	J. Elliott	J. Elliott
*585	West Hills	8 D	Oscar Jackson	J. H. Gutheil	J. H. Gutheil
*586	do	8 D	H. L. Stimpson	H. J. Dubois	H. J. Dubois

* For additional data see descriptive notes, pp. 168 et seq.
[a] Records transmitted to the Survey by Mr. W. H. C. Pynchon, civil engineer and geologist, Oyster Bay, N. Y.
[b] Flow varies with the tide.
[c] Depth July, 1903, 188.3.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Supply per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
3	99	.....	.....	[b] 20–100	Jameco?.....	.....	544
2	107	.....	+ 2	[b] 18	.....do.....	.....	545
3	[c] 200	.....	Flows.	[b] 10	.....do.....	.....	546
2	155.5	.....	Flows.	[b] 25	.....do.....	.....	547
.....	227	130	.....				548
.....	105	105	Flows.			.....	
3	90	.....	Flows.	[b] 100	Jameco?.....	.....	549
3	77	.....	Flows.	[b] 100	.....do.....	.....	550
2½	259	259	− 1	.....	Cretaceous.....	Well flows into pit.....	551
4	60	.....	− 3	.....			552
2	212	.....	+ 13	[b] 5		.....	
.....	465	465	Flows.	.....	Lloyd sand.....	Abandoned because of breaking of pipe.....	553
.....	378	.....	Flows.	[b] 45–75	.....do.....	.....	554
.....	370	360	Flows.	[b] 30	.....do.....	.....	555
.....	351	.....	Flows.	[b] 20–30	.....do.....	.....	556
.....	292	.....	Flows.	5–6	Cretaceous.....	Does not flow at low tide.....	557
.....	320	300–320	Flows.	50	Lloyd sand.....	.....do.....	558
.....	318	300–318	Flows.	25	.....do.....	.....	559
.....	295	.....	Flows.	8	Lloyd sand.....	.....	560
84	23	.....	− 17½	83	Pleistocene.....	Private water supply system supplying Pine Island Park and vicinity.	561
60–6	40	.....	− 27	25	.....do.....	.....	562
6	80	.....	.....	+25	.....do.....	.....	
6	45	.....	− 39	Large.	.....do.....	.....	563
3	330	300–330	.....	[b] 120	Lloyd sand.....	.....	564
8	27	.....	− 22	.....	Pleistocene.....	2 tile wells.....	565
2	24	.....	.....	.....	.....	Commission No. 1173. Slichter underflow station No. 1.	566
.....	.....	.....	.....	[d] 3,731	.....	.....	567
4½	37.5–106	.....	[e] Flow.	.....	Tisbury, Jameco?.....	Group of 106 wells.....	[f]
6	40	.....	− 12	[g] 72	Tisbury.....	.....	[f]568
2	31	.....	.....	.....	.....	Commission No. 849.....	569
2	18	.....	.....	.....	.....	Commission No. 1354.....	570
2	31	.....	.....	.....	.....	Commission No. 720.....	571
2	35.5	.....	.....	.....	.....	Commission No. 696.....	572
2	25	.....	.....	.....	.....	Commission No. 858.....	573
2	85	.....	.....	.....	.....	Commission No. 865.....	574
2	41.5	.....	.....	.....	.....	Commission No. 908.....	575
.....	55	.....	− 28	.....	.....	.....	576
20	34–36	.....	− 16	Large.	Pleistocene?.....	4 tile wells used for fire protection.....	577
12	40	.....	− 28	Large.	.....	Tile well.....	578
.....	.....	.....	.....	.....	.....	.....	[f]579
2	21	.....	.....	.....	.....	Commission No. 771.....	580
8	34	.....	− 25	.....	Pleistocene.....	.....	581
36–1¼	111	.....	.....	Good.	.....	.....	582
.....	65	.....	− 61	.....	.....	.....	583
8	70	.....	.....	.....	.....	.....	584
36–1¼	141.5	.....	.....	.....	.....	.....	585
2	343	.....	−294	7	Cretaceous.....	.....	586

[d] Average pumped from April 13, 1896, to December 31, 1896.
[e] Only the deeper wells flow.
[f] See Table VIII.
[g] Average for 1902.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*587	Woodbury	8 D	Richard Collier	W. C. Jaegle	W. C. Jaegle
*588	do	8 D	Decker Bros	do	do
*589	do	8 D	Fred Bosch		do
*590	do	8 D	Peter Hoenighausen		do
*591	Cold Spring station	8 D	Cold Spring Creamery	C. H. Danis	C. H. Danis
*592	do	8 D	H. A. Monfort	do	Ed. Danis, foreman
*593	West Hills	8 D	Mountain Mist Springs		
*594	Cold Spring Harbor	8 E	Columbia Farm	H. J. Dubois	H. J. Dubois
*595	do	8 E	do	do	do
*596	do	8 E	Walter R. Jones	C. H. Danis	C. H. Danis
597	do	8 E	Dr. O. L. Jones	do	Ed. Danis, foreman
*598	do	8 E	Mrs. Welton Wood	H. J. Dubois	H. J. Dubois
*599	do	8 E	Van Wyke heirs	do	do
600	do	8 E	Cold Spring Hatchery		
*601	do	8 E	W. E. Jones	C. H. Danis	C. H. Danis
*602	do	8 E	Edwin Jones		do
*603	do	8 E	G. E. Brightson	H. J. Dubois	H. J. Dubois
*604	do	8 E	L. C. Tiffany	do	do
605	do	8 E	do	do	do
606	do	8 E	Walter Hewlett	do	do
*607	do	8 E	Wm. White	C. H. Danis	Ed. Danis, foreman
*608	do	8 E	Joshua T. Jones	do	C. H. Danis
*609	do	8 E	L. C. Tiffany	do	do
*610	do	8 E	Henry De Forest	do	do
611	do	8 E	—— Bleeker	H. J. Dubois	H. J. Dubois
*612	do	8 E	R. De Forest	C. H. Danis	C. H. Danis
*613	do	8 E	Eagle Dock	do	do
*614	do	8 E	James Bowen	E. K. Hutchinson	Albert L. Webster, consulting engineer.
*615	do	8 E	L. V. Bell	Dollard Bros	Dollard Bros
*616	do	8 E	L. C. Tiffany	H. J. Dubois	H. J. Dubois
*617		8 E	Theo. Roosevelt	P. H. & J. Conlan	J. Conlan
618	Coopers Bluff	8 E	Long Island Sand Co		C. H. Danis
619	do	8 E	Sarah Talmon	E. K. Hutchinson	E. K. Hutchinson
*620	Cold Spring Harbor	8 E	T. S. Williams	C. H. Danis	C. H. Danis
*621	do	8 E	Walter Jennings	do E. K. Hutchinson	do E. K. Hutchinson
*622	do	8 E	Fred Conklin	H J. Dubois	H. J. Dubois
*623	West Neck	8 E	Robert De Forest	do	do
*624	Huntington	8 E	Alex. Denton	do	do
*625	do	8 E	H. J. Dubois	do	do
*626	do	8 E	Consolidated Ice Co	C. H. Danis	Engineer
*627	West Neck	8 E	Wilton Wood	H. J. Dubois	H. J. Dubois
*628	do	8 E	Barclay Ward	do	do
*629	do	8 E	Mrs. M. H. Clots	do	do
*630	Halesite	8 E	August Heckscher	do	do
*631	West Neck	8 E	Mrs. A. W. Marsh	C. H. Danis	C. H. Danis
632	do	8 E	Roland B. Conklin	Stotthoff Bros	Stotthoff Bros
*633	Lloyd Neck	8 F	Dr. O. L. Jones	Germantown Artesian Well Co.	Dr. O. L. Jones

*For additional data see descriptive notes, pp. 168 et seq.
[b] Flow varies with the tide.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Supply per minute	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
6	144	138–144	−100	+10	.....do.....		587
6–4	185	.....	.....	.....	.....	Well blows at 120 to 150 feet.....	588
.....	.....	.....	.....	.....	.....	Blowing well.....	589
.....	200	.....	.....	.....	.....	.....do.....	590
.....	96	.....	.....	.....	Cretaceous.....		591
4	195	.....	−135	25	.....do.....		592
Spring..	.....	.....	.....	.....	.....		593
4	235	.....	−200	Small.	Cretaceous.....		594
4	295	.....	.....	Small.	.....do.....		595
2	228	.....	−198	6	.....do.....		596
4	260	232–260	−232	25	.....		597
2	163	.....	− 5	.....	.....		598
.....	150	150	− 20	.....	Cretaceous.....		599
Spring..	.....	.....	.....	150	.....		600
3	195	.....	+ 2	[b] 7.5	Pleistocene.....		601
1¼	49	49	.....	[b] 5	.....do.....	No flow at low tide.....	602
.....	177	170–177	−117	.....	.....		603
6	243	235–243	.....	+30	.....		604
3	256	200–256	−150	.....	.....		605
.....	51	.....	− 4	.....	Pleistocene.....	Elevation about 20 feet above tide.....	606
3	179	179	Flows.	[b] 33	.....		607
3	70	66–70	Flows.	[b] 60	.....		608
.....	77	58–77	Flows.	[b] 75	.....	Initial flow estimated 125 gallons.....	609
.....	165	.....	.....	.....	.....		610
4	45	35–45	Flows.	.....	.....		611
6	184	177–184	Flows.	[b] 45–65	Cretaceous.....		612
3	176	.....	.....	3–5	Pleistocene.....		613
6	58	.....	.....	16–50	.....		614
.....	65	.....	− 50	.....	.....		615
8	.....	.....	− 15	.....	.....	Elevation, 40 feet above tide.....	616
4	140	.....	−125	25	.....		617
4	248	.....	.....	Large.	.....	Salt water.....	618
2	75	.....	.....	16	.....		619
.....	398	394–398	Flows.	10	Lloyd sand.....		620
3	76–92	.....	[c] Flows.	[d] 18–20	.....	Group of 3 wells.....	621
6	246	.....	.....	[d] 50	.....	.....do.....	
.....	68	.....	− 18	.....	.....		622
2	90	.....	− 25	.....	.....		623
.....	181	.....	−152	+10	.....		624
3	264	255–264	−144	.....	Cretaceous?.....		625
6	+60	.....	Flows.	5–10	Pleistocene.....	Pumps 80 gallons.....	626
3½	166	.....	− 40	.....	.....		627
3	499	.....	.....	0	.....		628
2	97	.....	− 35	.....	.....		629
4	142	.....	.....	[e] 10	Cretaceous.....		630
5	147	.....	.....	[e] 18			
36–4	131	.....	.....	.....	.....		631
.....	56	.....	− 32	25	Cretaceous.....		632
8	248.5	.....	Flows.	5	Lloyd sand.....		633

[c] At extremely high tide.
[d] Each well.
[e] Flows into underground cistern 17 feet below the surface.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
634	Lindenhurst	9 C	Breslau fire department	J. Elliott	J. Elliott
*635	1 mile northeast of Amityville.	9 C	Commission		Commission
*636	1 mile north of Lindenhurst.	9 C	do		do
*637		9 C	do		do
*638	Maywood	9 C	do		do
*639		9 C	do		do
*640		9 C	do		do
*641		9 C	do		do
*642	Pinelawn	9 D	do		do
*643	Colonial Springs	9 D	Roman Catholic Church		
*644	Dix Hills	9 D	Geo. Carll		Geo. Carll
*645	Melville	9 D	J. Elliott	J. Elliott	J. Elliott
646	Dix Hills	9 E			D. W. Johnson
647	Fairground	9 E	Alex. S. Gardner		Alex. S. Gardner
*648	do	9 E	A. C. Soper & Co	H. J. Dubois	A. C. Soper & Co
649	Huntington	9 E	F. Gallienne	do	H. J. Dubois
*650	do	8 E	Huntington Waterworks Co.		Oscar Darling, consulting engineer.
651	Halesite	9 E	Huntington Gas Co	H. J. Dubois	H. J. Dubois
*652	do	9 E	Huntington Light and Power Co.	do	do
*653	Centerport	9 E	R. F. Carmen	do	do
*654	do	9 E	R. S. McCrary	do	do
*655	do	9 E	C. A. Hallock	do	do
656	do	9 E	Hiram Ackerly	do	do
*657	do	9 E	J. J. Robinson	do	do
*658	Northport	9 E	Northport waterworks		Oscar Darling, consulting engineer.
				Henry Cabre	Henry Cabre
*659	Larkfield	9 E	A. O. Gildersleeve	W. C. Jaegle	A. O. Gildersleeve
*660	Northport	9 E	Fred Nevins	H. J. Dubois	Fred Nevins
661	do	9 E	Edward Thompson	Edward Thompson	Edward Thompson
*662	do	9 E	F. J. Smith		
*663	do	9 E	Dexter Cole		
*664	Little Neck	9 E	D. B. Moss	H. J. Dubois	H. J. Dubois
665	do	9 E	—— Morrell	do	do
*666	do	9 E	P. Van Iderstine's Sons	do	do
667	do	9 E	do	do	do
668	do	9 E		do	do
*669	Eaton Neck	9 F	Dr. O. L. Jones		C. H. Danis
*670	do	9 F	L. A. Bevin	C. H. Danis	do
*671	Muncie Island	10 B	Dr. E. H. Muncie	E. K. Hutchinson	E. K. Hutchinson[c]
672	Babylon (?)		Maude Adams	T. B. Rogers	T. B. Rogers
*673	Babylon	10 C	Long Island R. R		Engineer
*674	do	10 C	Sumpwams Water Co		E. Camerdon chief engineer
*675	Bayshore	10 C	Great South Bay Water Co	C. A. Lockwood	C. A. Lockwood

*For additional data see descriptive notes, pp. 168 et seq.
[a] Estimated yield per well.
[b] See Table VIII.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Supply per minute.	Geologic horizon of water-bearing strata.	Remarks.	No
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
18	25–35	.....	− 12 − 32	Large.	Pleistocene.....	Wells used for fire protection	634
2	25	.....	.....	.....	.....	Commission No. 743.....	635
2	21	.....	.....	.....	.....	Commission No. 757.....	636
2	2).5	.....	.....	.....	.....	Commission No. 729.....	637
2	30	.....	.....	.....	.....	Commission No. 728.....	638
2	92	.....	.....	.....	.....	Commission No. 826.....	639
2	30.5	.....	.....	.....	.....	Commission No. 763.....	640
2	31	.....	.....	.....	.....	Commission No. 758.....	641
2	42	.....	.....	.....	.....	Commission No. 772.....	642
.....	.....	.....	.....	.....	.....	The Colonial spring and the Mo-Mo-Ne spring.	643
.....	136	.....	−124	.....	.....	.....	644
8	56	.....	− 44	.....	.....	.....	645
.....	.....	.....	.....	.....	.....	12 feet of white clay in a cistern.....	646
3	374	.....	−150	20	Cretaceous.....	Small water-bearing horizon at 100 feet....	647
30–4	267	.....	−120	10	.....do.....	.....	648
2	205	.....	−113	7–8	.....	.....	649
8	60	.....	− 5	[a] 150	.....	3 wells	[b]650
3	102	.....	− 5	100	.....	Light-colored gravel 0 to 102 feet	651
4	75	.....	+ 2	.....	.....	.....	652
3	238	.....	−188?	.....	.....	.....	653
3	185	175–185	− 75	.....	Jameco?.....	.....	654
.....	42	.....	− 13	25	.....	.....	655
.....	131	.....	− 28	.....	.....	Bluish sandy clay 0 to 131 feet	656
.....	117	.....	− 19	.....	.....	.....	657
.....	.....	.....	.....	200	Pleistocene.....	Springs.....	658
8	50	.....	Flows.	[c] 125	Tisbury.....	Elevation 32 feet.....	[b]
2	51	.....	Flows.	12	.....do.....	.....	
6	186	172–186	−172	+25	.....	Soft water.....	659
2½	196	.....	−141	.....	.....	.....	660
1½	92	.....	Flows.	10–15	.....	.....	661
30	15	.....	− 11	.....	.....	Used for bottling.....	662
2	.....	.....	+ 5	.....	Pleistocene	Depth shallow, flows 2 gallons per minute..	663
4	75	67–75	− 48	Large.	.....	.....	664
3	50	.....	− 42	30	.....	.....	665
3	143	.....	−130	.....	.....	All sand and gravel.....	666
3	127	.....	−100	.....	.....	.....do	667
.....	28–55	.....	.....	.....	.....	Group of wells, all fine white sand.....	668
3	340	.....	0	.....	.....	Salt water; abandoned	669
.....	366	.....	[d] Flows.	.....	.....	.....do	670
3–2	270	200 270	Flows. Flows.	14 8	Cretaceous..... .....do.....	Dirty water..... Good water.....	671
6	140	.....	− 60	.....	Pleistocene?.....	.....	672
.....	22	.....	− 6	.....	.....	.....	673
8	70	.....	− 8	[f] 300	Pleistocene.....	Group of 4 wells	[b]674
5	40–45	.....	− 4	[g] 1,545	.....do.....	Group of 20 wells	[b]675

[c] Yield to pumps.
[d] Slight flow of salty water at high tide.
[e] Ann. Rept. Geol. Survey New Jersey for 1899, 1900, p. 79.
[f] Each well.
[g] Estimated capacity of whole station.

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TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
676	Deerpark	10 D	H. G. Totten		H. G. Totten
677	Commack	10 E	General		Postmaster
678	do	10 E	Victor F. Smith		Victor F. Smith
679	do	10 E	J. Otis Smith		J. Otis Smith
*680	Kings Park	10 E	Carl S. Burr	H. J. Dubois	H. J. Dubois
*681	Elwood	10 E	Captain Clarke	do	do
682	Larkfield	10 E?	Fred Parsons		
*683	Kings Park	10 E	Wm. Herod	Nelson W. Davis	Nelson W. Davis
684	do	10 E	Brewster Smith	Andrew J. Velsor	Andrew J. Velsor
*685	Middleville	10 E	Edward Thompson	H. J. Dubois	Edward Thompson
*686	Fort Salonga	10 E	J. F. McGiff	A. J. Velsor	A. J. Velsor
687	do	10 E	Edward Rowley	do	do
*688	do	10 E	Doctor Gillette	do	do
689	do	10 E	H. C. Brown		H. C. Brown
690	do	10 E	Justin Butterfield	A. J. Velsor	Justin Butterfield
*691	Bayshore	11 C	Great South Bay Water Co		C. A. Lockwood John C. Lockwood
*692	do	11 C	—— Strong	Ed. Schmidt	Ed. Schmidt
693	Islip	11 C	General		Postmaster
*694	Bayshore	11 C	Commission		Commission
*695	do	11 C	do		do
*696	East Islip	11 C	do		do
*697	Brentwood	11 D	do		do
*698	do	11 D	do		do
*699	Islip	11 D	do		do
*700	do	11 D	do		do
*701	do	11 D	do		do
*702	Central Islip	11 D	do		do
*703	do	11 D	do		do
704	do	11 D	Manhattan State Hospital		Dr. G. A. Smith, superintendent.
*705	Brentwood	11 D	St. Joseph's in the Pines		Oscar Darling, consulting engineer.
*706	do	11 D	General	J. Elliott	J. Elliott
*707	do	11 D	Commission		Commission
*708	do	11 D	do		do
709	Central Islip	11 D	General		Postmaster
*710	Hauppauge	11 D	Chas. Blyndenburgh	C. E. Price	C. E. Price
*711	Smithtown	11 E	C. B. Pedrick	do	do
*712	do	11 E	J. B. Payne	J. B. Payne	J. B. Payne
*713	Smithtown Branch	11 E	Fredrick Noback	C. E. Price	C. E. Price
*714	do	11 E	C. D. Smith	J. B. Redwood	J. B. Redwood
*715	do	11 E	E. M. Smith	T. B. Rogers	T. B. Rogers
*716	do	11 E	Chas. F. Leeman	do	do
*717	do	11 E	Rassapeaque Club	N. W. Davis	N. W. Davis

*For additional data see descriptive notes, pp. 168 et seq.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Supply per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
30	43	.....	− 37	.....	.....	.....	676
.....	15–75	15–30 50–75	.....	.....	.....	.....	677
36	96	.....	− 93	.....	.....	Soft water	678
36–6	110	.....	− 95	.....	.....	....do	679
36–3	142	138–142	.....	Large.	Cretaceous	.....	680
36–3	170	.....	.....	Small.	.....	.....	681
72	136	.....	−100	.....	.....	.....	682
6	152	.....	−142	.....	Tisbury	.....	683
30	153	.....	−148	.....	.....	All sand and gravel	684
1¼	33	.....	Flows.	.....	.....	.....	685
6	33	.....	Flows.	50	.....	.....	
6	162	.....	Flows.	10	.....	.....	
6–1¼	45	.....	Flows.	.....	.....	.....	
36–4	120	120	−110	.....	.....	.....	686
33	106	.....	−100	.....	.....	All sand and gravel	687
.....	73	.....	− 66	.....	.....	.....	688
.....	116	.....	.....	Small.	.....	.....	689
48	106	.....	−100	4	.....	.....	690
5	60	.....	.....	.....	Pleistocene	Group of wells; abandoned	691
.....	+262	262	Flows.	49.5	Cretaceous	Abandoned	
2	67	.....	− 7	.....	Pleistocene	.....	692
.....	[a] 12–15	.....	[a] − 8	.....	.....	.....	693
2	102.5	.....	.....	.....	.....	Commission No. 861	694
2	36	.....	.....	.....	.....	Commission No. 843	695
2	30	.....	.....	.....	.....	Commission No. 1086	696
2	30	.....	.....	.....	.....	Commission No. 1087	697
2	30.5	.....	.....	.....	.....	Commission No. 1088	698
2	40.5	.....	.....	.....	.....	Commission No. 842	699
2	41	.....	.....	.....	.....	Commission No. 830	700
2	35	.....	.....	.....	.....	Commission No. 1186	701
2	25	.....	.....	.....	.....	Commission No. 1194	702
2	35	.....	.....	.....	.....	Commission No. 1183	703
2	40	.....	− 21	[b] +125	Pleistocene	Group of 17 wells	704
8	52	.....	− 25	150	Pleistocene?	.....	705
.....	50–80	.....	− 28 − 52	.....	.....	.....	706
2	103	.....	.....	.....	Pleistocene	.....	707
2	44	.....	.....	.....	.....	Commission No. 1141	708
.....	50–60	.....	− 45 − 50	.....	Pleistocene?	Commission No. 1195	709
.....	49.5	.....	− 43	.....	.....	.....	710
.....	168	165–168	.....	.....	Pleistocene	.....	711
2	127	.....	− 30	.....	.....	Soft water; incomplete	712
36–2	125	125	− 50	.....	Pleistocene	Hard water	713
.....	95	.....	− 84	.....	....do	.....	714
6	100	.....	− 85	.....	.....	.....	715
.....	160	.....	.....	.....	.....	.....	716
6	18	Flows.	60	.....	.....	.....	717

[a] Average for this vicinity.

[b] For whole system.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*718	King's Park	11 E..	Society of St. Johnsland	George Schmidt	Society of St. Johnsland.
*719	do	11 E..	Long Island State Hospital.	Hudson Engineering and Contracting Co.	Long Island State Hospital.
720	Nissequogue River	11 E..	W. W. Kenyon	H. J. Dubois	H. J. Dubois
*721	do	11 E..	W. J. Matherson	C. H. Danis	C. H. Danis
*722	do	11 E..	L. Harris	T. B. Rogers	T. B. Rogers
*723	Stony Brook Harbor	11 E..	R. H. Smith	do	do
*724	do	11 E..	H. W. Reboul	do	do
725	Oakdale	12 C..	W. K. Vanderbilt	J. Elliott	J. Elliott
726	do	12 C..	F. G. Bourne	do	do
*727	do	12 C..	C. R. Roberts	Theo. J. Kirk	Theo. J. Kirk
728	West Sayville	12 C..	General		Postmaster
*729	Sayville	12 C..	Commission		Commission
*730	Ronkonkoma	12 D..	do		do
*731	do	12 D..	do		do
*732	do	12 D..	do		do
733	do	12 D..	General		Postmaster
*734	do	12 D..	John Klaiber	S. E. Terry	S. E. Terry
735	Lake Ronkonkoma	12 D..	F. G. Hallock	Arthur & Tuthill	W. T. Arthur
*736	do	12 D..	Wm. Ralston	Wm. Ralston	Wm. Ralston
*737	do	12 D..	J. Weber	Arthur & Tuthill	W. T. Arthur
*738	do	12 D..	George E. Plunkett	do	do
*739	do	12 D..	R. W. Newton	T. B. Rogers	T. B. Rogers
*740	do	12 D..	W. Imhauser estate	Arthur & Tuthill	W. T. Arthur
*741	do	12 D..	Nelson Newton	Wm. Ralston	Wm. Ralston
742	do	12 D..	E. Hollis Newton		E. Hollis Newton
*743	do	12 D..	W. H. Warner	Arthur & Tuthill	W. T. Arthur
*744	Lake Grove	12 E..	John Morrissey	S. E. Terry	S. E. Terry
*745	do	12 E..	Irving Overton	do	do
*746	do	12 E..	Dr. Monecke	do	do
747	do	12 E..	M. A. Metzner		B. Franklin Hallock
748	do	12 E..	B. Franklin Hallock	T. B. Rogers	do
*749	St. James	12 E..	Commission		Commission
*750	do	12 E..	Father Ducey	T. B. Rogers	T. B. Rogers
*751	do	12 E..	Jerome Saxe	do	do
*752	do	12 E..	D. Emmett	do	do
*753	do	12 E..	do	do	do
*754	do	12 E..	do	A. J. Velsor	A. J. Velsor
*755	do	12 E..	Commission		Commission
*756	do	12 E..	do		do
*757	Stony Brook	12 F..	Chas. T. Darling	Plat Gildersleeve	Chas. T. Darling
758	do	12 F..	Wm. Shipman estate	do	do
*759	do	12 F..	George Erland, sr	T. B. Rogers	T. B. Rogers
*760	Setauket	12 F..	Woodhull Rowland	do	do
*761	do	12 F..	Wm. Clarke	do	do
*762	do	12 F..	Howard Wallace	do	do
*763	do	12 F..	Wilmot T. Cox	E. K. Hutchinson	Wilmot T. Cox
*764	do	12 F..	Nort House	Nelson W. Davis	Nelson W. Davis
*765	do	12 F..	Chas. Benner	do	do

*For additional data see descriptive notes, pp. 168 et seq.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Supply per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
6	68	.....	− 55	.....	.....	Hard water	718
6	90	40	[a] Flow.	[b] 625	Pleistocene	Group of 12 wells. Water hard and salty.	719
4	212	196–212	−114	.....	.....	Soft water	720
3	140	.....	− 8	.....	Cretaceous ?	.....	721
.....	100	.....	− 80	.....	Tisbury	All sand	722
.....	117	.....	− 60	.....	Tisbury ?	.....	723
.....	110	.....	− 80	.....	.....do	All sand	724
12	50	.....	− 10	.....	Pleistocene	2 tile wells	725
12	40	.....	− 5	.....	.....do	.....do	726
2	170	.....	.....	.....	.....	Water unsatisfactory	727
.....	10–50	.....	− 12 − 20	.....	.....	.....	728
2	45	.....	.....	.....	.....	Commission No. 1198	729
2	62	.....	.....	.....	.....	Commission No. 1196	730
2	56	.....	.....	.....	.....	Commission No. 1200	731
2	25	.....	.....	.....	.....	Commission No. 1202	732
.....	60–90	.....	− 65	.....	.....	.....	733
8	81	63–81	− 63	.....	Pleistocene ?	.....	734
1½	73	63–73	− 63	.....	.....	All white sand	735
36	54	.....	− 50	.....	Pleistocene	.....	736
1½	117	32 112	− 31	.....	.....do	Soft water	737
36–1½	70	.....	− 62	.....	.....	.....	738
6	60	.....	− 48	.....	Pleistocene	.....	739
1½	75	.....	− 8	.....	Pleistocene ?	.....	740
36	33	.....	− 30	.....	.....	.....	741
40	27	.....	− 23	5	.....	Hard water	742
½	47	.....	− 35	.....	.....	Water used for local irrigation	743
8	86	.....	− 72	.....	.....	.....	744
8	58	.....	− 52	.....	.....	.....	745
8	24	.....	− 17	.....	.....	Clay 8 to 21 feet	746
.....	.....	.....	.....	.....	.....	Group of 4 wells used for irrigation	747
2	38	.....	− 28	.....	.....	.....	748
2	59	.....	.....	.....	.....	Commission No. 1205	749
6	150	.....	−132	Large.	Pleistocene	.....	750
6	250	.....	−208?	.....	Tisbury	.....	751
6	300	.....	− 90	.....	.....	.....	752
6	97	.....	− 83	.....	Tisbury	.....	753
36	160	.....	−156	.....	.....	.....	754
2	90	.....	.....	.....	Tisbury	Commission No. 1206	755
2	70	.....	.....	.....	.....do	Commission No. 1236	756
30–6	123	88.5–123	− 88.5	.....	.....do	All sand	757
36	90	.....	.....	.....	.....do	.....do	758
6	107	.....	.....	.....	.....	.....	759
6	252	.....	.....	.....	Cretaceous	.....	760
6	90	.....	− 75	.....	.....	.....	761
6	70	.....	− 50	.....	Tisbury	.....	762
6	320	.....	Flows.	+18	Cretaceous	Flow varies with the tide	763
2	40	.....	− 24	.....	Pleistocene?	.....	764
3	50	.....	− 44	.....	.....do	.....	765

[a] When not pumping.

[b] Yield to pumps from whole plant of 12 wells.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*766	Crane Neck	12 F.	Elversley Childs	T. B. Rogers	T. B. Rogers
767	do	12 F.	Frank Melville, jr	do	do
*768	do	12 F.	John Thatcher	do	do
*769	Old Field Point	12 F.		do	do
*770	do	12 F.	General	do	do
*771	Mount Misery Point	12 F.		Cole Bros	Cole Bros
*772	Sayville	13 C.	General		Postmaster
*773	Bayport station	13 C.	Long Island R. R	Arthur & Tuthill	W. T. Arthur
*774	Patchogue	13 C.	Sea Cliff Hotel	Theo. J. Kirk	Theo. J. Kirk
*775	do	13 C.	Nassau Oyster Co	do	do
*776	do	13 D.	Theo. J. Kirk	do	do
777	do	13 D.	Great South Bay Water Co.		
*778	do	13 D.	Commission		Commission
*779	do	13 D.	do		do
*780	do	13 D.	do		do
*781	do	13 D.	do		do
*782	Holbrook	13 D.	—— Reynolds	Theo. J. Kirk	Theo. J. Kirk
783	Holtsville	13 D.	C. B. Dedrick		C. B. Dedrick
*784	Farmingville	13 E.	Commission		Commission
*785	do	13 E.	A. P. Terry	S. E. Terry	S. E. Terry
*786	do	13 E.	August Fuch	do	do
*787	do	13 E.	D. Schwarting	do	do
*788	do	13 E.	Wm. Clark	do	do
*789	do	13 E.	Mrs. Max Richter	do	do
*790	Farmingville (?)	13 E ?.	Frank Franz	Theo. J. Kirk	Theo. J. Kirk
*791	Selden	13 E.	John F. Byrne	S. E. Terry	S. E. Terry
*792	do	13 E.	Doctor Emerson	do	do
*793	do	13 E.	Axel Hodges	do	do
*794	New Village	13 E.	Adolph Sembler	do	do
*795	Terryville	13 E.	Commission		Commission
*796	do	13 E.	do		do
*797	Echo	13 F.	do		do
*798	do	13 F.	do		do
799	do	13 F.	Thos. Marsh	Nelson W. Davis	Nelson W. Davis
*800	Port Jefferson	13 F.	J. J. Overton	do	do
*801	do	13 F.	J. L. Darling	do	do
802	do	13 F.	J. H Davis	do	do
*803	do	13 F.	Port Jefferson Water Co.	T. B. Rogers	T. B. Rogers
*804	do	13 F.	Nelson W. Davis	Nelson W. Davis	Nelson W. Davis
805	do	13 F.	—— Dryer	do	do
*806	do	13 F.	A. T. Norton	do	do
*807	do	13 F.	J. W. Brown	do	do
*808	do	13 F.	J. Biddle	do	do
809	do	13 F.	Port Jefferson Fire Co	do	do
810	do	13 F.	Port Jefferson Co	Pierce Well Engineering Co.	Pierce Well Engineering Co.
*811	do	13 F.	do	T. B. Rogers	T. B. Rogers
*812	Mount Sinai	13 F.	J. H. Hopkins	Nelson W. Davis	Nelson W. Davis
*813	Bellport	14 D.	Joseph M. Shaw	Arthur & Tuthill	W. T. Arthur

*For additional data see descriptive notes, pp. 168 et seq.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Supply per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
.....	38	.....	− 12?	.....	Pleistocene	Salt water	766
6	80	.....	.....	.....	Tisbury?	All sand and gravel	767
6	65	.....	− 30	+15	.....	.....	768
6	50	.....	.....	.....	.....	Salt water	769
1½	43	36	.....	.....	.....	Fresh water	770
8–6	275	.....	.....	.....	.....	Well abandoned	771
.....	40–45	.....	− 30	.....	Pleistocene	.....	772
1½	28	.....	.....	.....	.....	.....	773
.....	8	.....	.....	.....	.....	.....	774
2	72	.....	.....	.....	.....	Black water; abandoned	775
2	19	.....	− 17	.....	.....	Good water	
2	28	.....	− 18	.....	Pleistocene	.....	776
.....	Shallow.	.....	.....	.....	.....	Pumping station	[a]777
2	150	.....	.....	.....	.....	Commission No. 1145	778
2	50	.....	.....	.....	.....	Commission No. 1184	779
2	50	.....	.....	.....	.....	Commission No. 1007	780
2	51	.....	.....	.....	.....	Commission No. 1169	781
1½	90	.....	− 80	.....	Tisbury?	.....	782
36	46	.....	− 40	.....	.....	.....	783
2	50	.....	.....	.....	.....	Commission No. 1008	784
12	110	.....	.....	.....	Pleistocene	.....	785
8	70	.....	− 65	.....	.....do	.....	786
8	27	.....	− 22	.....	.....do	.....	787
8	59	.....	− 52	.....	.....do	.....	788
8	60	.....	− 54	.....	.....	.....	789
2	80	.....	− 70	.....	.....	.....	790
8	64	.....	.....	.....	.....	.....	791
8	59	.....	− 54	.....	.....	.....	792
8	38	.....	− 26	.....	.....	.....	793
8	38	.....	− 32	.....	.....	.....	794
2	70	.....	.....	.....	.....	Commission No. 1237	795
2	59	.....	.....	.....	Tisbury?	Commission No. 1214	796
2	85	.....	.....	.....	.....	Commission No. 1233	797
2	90	.....	.....	.....	.....	Commission No. 1215	798
.....	150	.....	−145	Large.	.....	.....	799
4	20	.....	Flows.	.....	.....	.....	800
3	96	.....	− 40	.....	.....	.....	801
2	±25	.....	Flows.	5	.....	.....	802
6	54	.....	Flows.	.....	Pleistocene	2 wells. Pumps 133 gallons per well per minute.	803
6	75.5	.....	Flows.	25	.....do	.....	804
1½	60	.....	Flows.	.....	.....	This well ceased to flow when No. 804 was completed.	805
1½	140	140	.....	.....	.....	.....	806
2	90	.....	− 70	.....	.....	.....	807
3	120	.....	−110	.....	.....	.....	808
.....	Shallow.	.....	.....	100	Pleistocene	Wells for fire protection	809
2	35	.....	Flows.	.....	.....	Temperature 58° F.; pumps 42 gallons per minute.	810
.....	370	.....	.....	Small.	Cretaceous	.....	811
2½	95	.....	− 88	Good.	.....	.....	812
1½	45	.....	− 20	.....	.....	.....	813

[a] See Table VIII.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*814	2 miles west of Yaphank station.	14 D..	Walter McGee	S. E. Terry	S. E. Terry
815	Yaphank	14 E..	Dr. C. A. Baker		Dr. C. A. Baker
816	Coram	14 E..	E. S. Still	S. E. Terry	S. E. Terry
817	Middle Island	14 E..	Wm. Davis	Nelson W. Davis	Nelson W. Davis
*818	.....do	14 E..	Judge Bartlett	S. E. Terry	S. E. Terry
*819	Rocky Point	14 F..	Hawman Bros	Nelson W. Davis	Nelson W. Davis
820	.....do	14 F..	Long Island R. R		Long Island R. R
821	Brookhaven	15 D..	General		Postmaster
*822	Manorville	15 E..	Mrs. Groty	J. W. Nichol	J. W. Nichol
823	Wading River	15 F..	Mary Miller	Preston Raynor	Preston Raynor
*824	Wardenclyffe	15 F..	Geo. E. Hageman	Nelson W. Davis	Nelson W. Davis
*825	.....do	15 F..	Nikola Tesla	T. B. Rogers W. H. Beers	Nikola Tesla W. H. Beers
*826	Woodville Landing	15 F..	North Shore Industrial Co. J. S. Warden		Jas. S. Warden S. B. Saxe
*827	.....do	15 F..	Wardenclyffe Brick and Tile Co.		Jas. S. Warden
*828	Wading River	15 F..	Long Island R. R	Dollard Bros	Dollard Bros
*829	.....do	15 F..	Mrs. De Groat	J. W. Nichol	J. W. Nichol
*830	.....do	15 F..	S. W. Wheeler	Nelson W. Davis	Nelson W. Davis
*831	Center Moriches	16 D..	Dr. Wm. Carr	Robinson Bros	Robinson Bros
*832	.....do	16 D..	Otto Lauraman	.....do	.....do
*833	.....do	16 D..	Wm. Hallock	.....do	.....do
834	.....do	16 D..	—— Kroln	.....do	.....do
835	.....do	16 D..	Dr. A. J. Woodruff	Arthur & Tuthill	W. T. Arthur
*836	East Moriches	16 D..	W. Frank Smith		W. Frank Smith
837	.....do	16 D..	George Harris		George Harris
*838	South Manor	16 E..	Wesley Young	J. W. Nichol	J. W. Nichol
*839	.....do	16 E..	Alfred Steele	.....do	.....do
*840	.....do	16 E..	Benj. Raynor	.....do	.....do
*841	.....do	16 E..	Wallace Raynor	.....do	.....do
*842	.....do	16 E..	Porter Howell	.....do	.....do
*843	Manorville	16 E..	J. W. Nichol	.....do	.....do
*844	.....do	16 E..	M. E. Raynor	.....do	.....do
*845	.....do	16 E..	Long Island R. R		Long Island R. R
*846	.....do	16 E..	Mrs. Jones	J. W. Nichol	J. W. Nichol
*847	.....do	16 E..	Preston Raynor	Preston Raynor	Preston Raynor
*848	Hulse Landing	16 E..	Dr. J. H. Darlington	W. H. Beers	Dr. J. H. Darlington
*849	Remsenburg	17 D..	R. B. Dayton		R. B. Dayton
*850	Speonk	17 D..	Jacob Raynor	Arthur & Tuthill	W. T. Arthur
*851	.....do	17 D..	Ellsworth Raynor	.....do	.....do
*852	.....do	17 D..	W. C. Rogers	.....do	.....do
853	Calverton	17 E..	Mrs. Robinson	Wm. V. Young	Wm. V. Young
	.....do	17 E..	General		Postmaster
*854a	Baiting Hollow	17 F..	Chas. H. Wells	Wm. V. Young	Wm. V. Young
*855	.....do	17 F..	Charles Warner	Arthur & Tuthill	W. T. Arthur

*For additional data see descriptive notes, pp. 168 et seq.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Supply per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
8	68	.....	− 62	.....	.....	.....	814
36 1½	18–24	.....	− 16 − 18	.....	.....	.....	815
8	33	.....	.....	.....	Wisconsin	All morainal material	816
4	62	.....	− 12	.....	.....	Medium white sand 0 to 62 feet	817
8	39	8 32	− 30	.....	Wisconsin	.....	818
4	128	.....	−121	12–15	Tisbury?	.....	819
4	120	.....	−106	.....	.....	.....	820
.....	14–20	.....	− 8 − 10	.....	.....	.....	821
1¼	29	29	− 21	.....	.....	Clay 3 to 29 feet	822
2	50	.....	.....	.....	Tisbury?	All sand and gravel	823
3	123	.....	−113	.....	.....	.....	824
8	166	.....	−110	15	Tisbury	Water pure and soft	825
.....	347	.....	.....	.....	.....	Experimental well	
60–8	94	.....	− 57	.....	Tisbury	.....	826
.....	90	.....	− 50	.....		.....	
48–3	57	.....	− 4	.....	Jameco?	Clay from 0 to 47 feet	827
.....	110	.....	− 80	.....	.....	.....	828
1¼	38	.....	.....	0	.....	Abandoned	829
3	68	.....	− 28	.....	Tisbury	.....	830
3	20	.....	.....	.....	Pleistocene	.....	831
1¼	34	.....	.....	.....	....do	.....	832
1¼	20	.....	.....	.....	....do	.....	833
3	67	.....	.....	.....	....do	All sand and gravel	834
1¼	26	.....	− 10	.....	....do	....do	835
3	33	.....	− 28	.....	....do	Soft water	836
28	60	.....	− 56.5	.....	....do	....do	837
1¼	22	.....	− 18	.....	.....	Sand and stones 2 to 22 feet	838
1¼	15	.....	− 12	.....	.....	Sand 2 to 15 feet	839
1¼	24	.....	− 22	.....	.....	Clay 22 to 24+ feet	840
1½	36	+36	− 5 − 10	.....	Pleistocene?	Clay 3 to 15, 19 to 36 feet	841
3	20	.....	− 15	.....	....do	.....	842
1¼	12	.....	− 9	.....	....do	Clay 6 to 7 feet	843
1¼	15	.....	− 12	.....	....do	.....	844
.....	.....	.....	.....	.....	.....	.....	845
1½	42	.....	.....	.....	Pleistocene?	Clay 3 to 42 feet	846
1¼	42	.....	.....	.....	.....	Clay 3 to 40 feet	847
	32	.....	.....	.....	.....	Clay 12 to 28 feet	
3	92	92	− 87	Large.	.....	.....	848
1½	25	10–25	− 10	20	Pleistocene	.....	849
1¼	29	.....	− 21	.....	....do	Clay 21 to 25 feet	850
1¼	26	.....	.....	.....	.....	Clay 18 to 20 feet	851
1¼	26	.....	− 20	.....	Pleistocene	.....	852
.....	65	.....	− 54	.....	Pleistocene?	All sand and gravel	853
.....	20–50	.....	− 20	.....	.....	.....	
3	105	.....	− 94	.....	.....	.....	854
2½	99	.....	− 90	.....	.....	.....	855

[a] Other wells also numbered 854 have similar sections.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*856	Baiting Hollow	17 F.	Howell Sandford	Arthur & Tuthill	W. T. Arthur
*856 A	Centerville	17 F.	Sydney Shaw	S. E. Terry	S. E. Terry
*857	West Hampton Beach.	18 D.	Augustus Zabriskie	Arthur & Tuthill	W. T. Arthur
*858	Quogue Beach	18 D.	Hallock & Small	Nelson W. Davis	Nelson W. Davis
*859	Quogue	18 D.	Asha B. Hallock	do	Asha B. Hallock
*860	do	18 D.	J. Wendell	Cole Bros.	Cole Bros.
*861	do	18 D.	Quantuck Water Co.		Henry Gardner, treasurer.
862	Quogue Station	18 E.	Long Island R. R.		Long Island R. R.
*863	Riverhead	18 E.	Riverhead Waterworks	Nelson W. Davis	Nelson W. Davis; John R. Perkins
*864	do	18 E.	Yetter & Moore	W. V. Young	W. V. Young
865	Northville	18 F.	Chas. Wells	A. O. Ryder	A. O. Ryder
866	Cum City	18–19 F	Nicholas Brown	do	do
867	Good Ground	19 E.	General		S. L. Squires
868	do	19 E.	Gilsey estate	J. Elliott	J. Elliott
*869	Jamesport	19 F.	Capt. Jas. Downs	W. V. Young	W. V. Young
*870	do	19 F.	John J. McLaughlin		Chas. Darling, consulting engineer.
871	Mattituck	19 F?.	F. M. Lupton		do
*872	do	19 F.	Long Island R. R.		Long Island R. R.
873	do	19 F-G	General		Dr. E. K. Morton
*874	Shinnecock Hills	20 E.	—— Thane	Chester D. Corwin	Chester D. Corwin
*875	North Sea	20–21 F	Chas. W. Payne	W. T. Arthur	W. T. Arthur
876	New Suffolk	20 F.	Donald Goldsmith	Arthur & Tuthill	do
*877	do	20 F.	—— Reid	do	do
878	Southold	20–21 G		Nelson W. Davis	Nelson W. Davis
*879	Southampton	21 E.	Southampton Water Co.		Oscar Darling, consulting engineer; Geo. Elliston, engineer
*880	Hampton Park	21 E.	Mrs. S. F. McDonald	Arthur & Tuthill	W. T. Arthur
*881	do	21 E.	Edward G. Whittaker	do	do
*881 A	Water Mill	21 E.	General		Frederick H. Rose
*882	Shelter Island	21 G.	John F. Becker	Harry Strausbinger	Harry Strausbinger
*883	do	21 G.	—— Ulmer	do	do
*884	do	21 G.	John Weber	do	do
*885	do	21 G.	J. N. Stearns	A. O. Ryder	A. O. Ryder
886	do	21 G.	Mrs. Post	Nelson W. Davis	Nelson W. Davis
887	do	21 G.	Capt. Max Walthers	A. O. Ryder	A. O. Ryder
*888	do	21 G.	A. O. Ryder	do	do
*889	Shelter Island Heights.	21 H.	Shelter Island Heights Association.		Wesley Smith, superintendent.
*890	Shelter Island	21 H.	Manhanset House		W. H. Havens, chief engineer.
891	Greenport	21 H.	J. Madison Wells	A. O. Ryder	A. O. Ryder

*For additional data see descriptive notes, pp. 168 et seq.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above (+) or below (−) ground level.	Supply per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
2½	104		− 96				856
12–3	109		− 92				856 A
2–1½	20				Pleistocene	Fluctuates with the tide	857
	225	225	+ 12		Cretaceous	Flows 16 gallons per minute	858
	277		+ 3		do	Flows 1 gallon per minute	859
8	277		Flows.	1–2	do		860
8	40		− 4	[a] 347		Group of 6 wells [b]	[b] 861
4	42–46		− 30			2 wells	862
8	225		Flows.			([b])	
6	305		Flows.				
		83	Flows.			Flows 150 gallons	863 ([b])
		225	Flows.			Pumps 133 gallons	
		305	Flows.				
	16		− 5				864
	150		−135		Pleistocene?	All coarse white sand	865
	35		− 30		Pleistocene	All medium red sand	866
	15–90		[c] − 40 − 50	Fair.	do		867
8	32		− 22		do	All light-colored sand and gravel	868
	45		− 6				869
2 4	70	60–70	− 7	30–40		All sand	870
4	30		− 16	50	Pleistocene	do	871
	20						872
	12–90		− 12 − 90	Good.	Pleistocene		873
	35				do		874
1½	25				do		875
	28.5		− 25			All white sand	876
1½	88			0		Clay 4 to 88 feet	877
	70					Clay 40 to 60 feet	878
	80		− 27				879 ([b])
8	80		− 35	[d] 683	Pleistocene	Group of 3 wells	
1½	80			Small.		Clay 34 to 80 feet	880
3	111		−100		Jameco?	Clay 2 to 82 feet	881
					Pleistocene		881 A
36	52						882
36	43				Pleistocene		883
	53				do		884
	35		− 30		Sankaty		885
	60		− 50		Tisbury	All sand and gravel	886
	73		− 68		Tisbury?	do	887
	62		− 50		Sankaty		888
36–6	33		− 18	100	Tisbury		889 ([b])
	60			0			
36	36						
	65		− 32		Tisbury	Group of 18 wells	[b] 890
	45	35–45	− 45		Jameco?		891

[a] Estimated. [b] See Table VIII. [c] Average. [d] Test for whole station of 3 wells.

TABLE XI.—*Representative wells*

No.	Location.	Coordinates.	Owner.	Driller.	Authority.
*892	Greenport	21 H.	Village of Greenport		W. E. Reynolds
*893	do	21 H.	Long Island R. R		Long Island R. R
*894	East Marion	21 H.	East Marion Life-Saving Station.	A. O. Ryder	A. O. Ryder
*895	do	21 H.	W. F. Furst		W. F. Furst
896	do	21 H.	General		Postmaster
*897	Bridgehampton	22 F.	Jas. A. Sanford & Son.	Jas. A. Sanford & Son.	Jas. A. Sanford
898	do	22 F.	General		Postmaster
899	Sagaponack	22 F.	do		do
*900	do	22 F.	J. Wilkes Hedges		J. Wilkes Hedges
*901	Sag Harbor	22 F.	John K. Morris	I. H. Ford	John K. Morris
902	do	22 F.			
*903	do	22 F.	Sag Harbor Waterworks Co	E. Camerdon	E. Camerdon H. F. Cook, president
*904	do	22 F.	Fahy Watch Case Co	Frank Wankel	Frank Wankel
*905	do	22 F-G	Chas. W. Payne		John H. Hunt
906	Shelter Island	22 G.	F. M. Smith	A. O. Ryder	A. O. Ryder
*907	do	22 G.	Doctor Benjamin	do	do
*908	do	22 G.	J. Eugene Parker	do	do
*909	Orient (Long Beach)	22 H.	Orient Manufacturing Co	Uriah White	
*910	Easthampton	23 F.	Easthampton Home Water Co.	W. C. Jaegle	J. A. Worthington, engineer.
*911	Plum Island	23 I.	U. S. Army		O. W. Degen[d]
912	Amagansett	24 F.	General		Postmaster
*913	do	24 F.	Long Island R. R	C. A. Lockwood	C. A. Lockwood
*914	Gull Island	24 I.	U. S. Army		O. W. Degen[d]
*915	Montauk	26 G.	do	C. A. Lockwood	C. A. Lockwood
*916	do	26 G.	Long Island R. R		Long Island R. R
*917	do	26 G.	Fort Pond		do
*918		26 G.	Great Pond		do
*919	Fishers Island	26 J.	E. M. & W. Ferguson	C. L. Grant	C. L. Grant

* For additional data see descriptive notes, pp. 168 et seq.
[a] Reported test of first 4 wells.
[b] See Table VIII.

on Long Island—Continued.

Diameter of well.	Depth of well.	Depth of principal water supply.	Height of water above(+) or below(−) ground level.	Supply per minute.	Geologic horizon of water-bearing strata.	Remarks.	No.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*			
6	28–48			[a] 300	Pleistocene		892
6–4	690	665	Flow.		Lloyd sand?	Abandoned; rock below 670; supply very small.	[b]
	15–20					Analyses	893
	12						
	50		− 48		Tisbury		894
	35						895
	18–36		− 18		Pleistocene		896
			− 30				
	300		− 35		Cretaceous		897
	20–60		− 25		Pleistocene		898
	20–40		− 30		....do		899
			− 15				
			− 40		....do		900
6	185		−145?		Pleistocene ?		901
						"Mineral springs;" a large chalybeate spring	902
6	40–100		− 3		Pleistocene	Abandoned for surface supply	[b] 903
	60						
		40					
		90					
	182	130	− 14	500	....do	Abandoned because of contamination from chemicals in factory.	904
		155–160					
	80	80				Brackish water, 3 to 20 feet	905
	38		− 35		Tisbury	All sand	906
	60		− 40		Sankaty ?		907
	76		− 71		Tisbury		908
	+406					Struck rock and well abandoned	909
6	75–86		− 32½	[c] 166	Pleistocene	Group of 3 wells	[b] 910
	69						
6	85		− 28		Pleistocene ?	Group of 3 wells	911
	89						
	20–50		[e] − 45		Pleistocene		912
10	107		− 67	+15	....do		913
8–4	291	91	[f] Flow.			Salt water, 0 to 110 feet; abandoned	914
8–10	30		− 13	52	Pleistocene		915
	37	10		69			
						Analysis	916
						....do	917
						....do	918
6	485					Rock at 204 feet; abandoned	919

[c] Test of single well.
[d] Superintendent of construction and civil engineer, quartermaster's department.
[e] Average.
[f] Salt water.

DESCRIPTIVE NOTES.

[Numbers in black-faced type correspond to those used in the table preceding.]

1. The sample from this well preserved in Mr. Gregory's office, marked "Hoffmans Island 210 feet," is a dark, bluish-gray sand, apparently glacial.

Record of quarantine station well, Hoffmann Island, New York.

	Feet.
1. Sand, clay, and gravel, with salt water	0–450
2. Rock, with salt water	450–750
3. Rock, with fresh water	750–1,000

2. In 1867 John Nadir, United States engineer at Fort Hamilton, carefully examined the underlying formations at Fort Lafayette, making borings 800 to 1,000 feet from the shore. These borings showed the following section:[a]

Generalized record of United States Army test borings at Fort Lafayette, N. Y.

	Feet.
1. Coarse sand and gravel, with a few broken shells	0–20
2. Decayed marsh or meadow mud with diatomaceæ and spiculæ of sponges and shells	20–23
3. Gravel and sand containing many broken shells	23–40
4. Mud, quite compact, which appears to have been a marsh with scanty vegetation, rather than a meadow. In this formation a great number of shells were found which were identified as *Nassa obsoleta, Anomia ephippium, Mya arenaria, Crepidula fornicata, Solen ensis, Mytilus edulis*	40–53

3. See plan and cross section of south Brooklyn tunnel, by Isaiah Bowman, from notes furnished by J. C. Meem, civil engineer (Pl. XXV). Mr. Meem states that in order to keep the tunnel dry 750,000 to 1,000,000 gallons per day were pumped from each of the seven shafts.

4. Mr. L. B. Ward gives the following data:[b] "This company has no municipal contract. Its area of operation comprises Blythebourne and Borough Park tracts, situated in the Thirtieth Ward. The supply is pumped from open wells at a depth of 80 feet. The works consist of 1 principal pumping station, and 1 reserve station, also 5 elevated tanks (wooden structures) of 25,000 gallons each. Daily pumpage 200,000 gallons. An average of 106,000 gallons per day is also received from the city."

5. Mr. J. C. Breckenridge, general manager of the Brooklyn Rapid Transit Company, in a letter dated April 29, 1901, gives the following data regarding this well: "Well was put down 1,503 feet; 8 inches in diameter to 1,000 feet, and 6 inches below that point. It was never pumped to determine the yield, as the water always tested salty and unfit for boiler use. The original plan was to go down to a fissure in the bed rock where it was supposed a stream of running water suitable for boiler use could be found. The nature of the material penetrated was as follows:

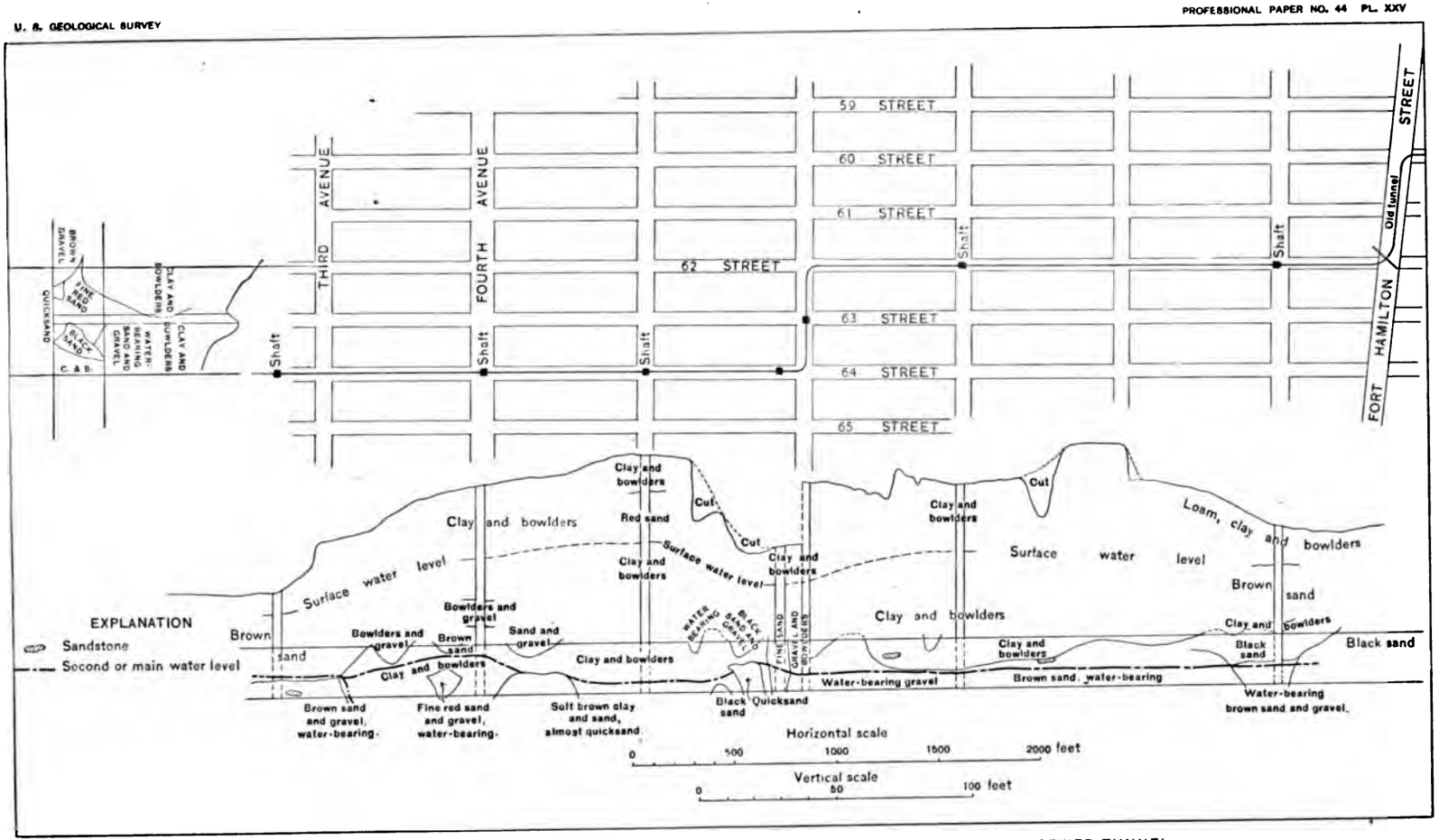
Record of Brooklyn Rapid Transit Company's well at Brooklyn, N. Y.

	Feet.
Wisconsin and Tisbury:	
1. Sand	0–73
2. Clay	73–95
Sankaty:	
3. Fine sand	95–101
4. Clay	101–139
Jameco:	
5. "Hard pan," with small stones, black, and varying in size	139–169
6. Coarse sand	169–189
7. "Hard pan" to bed rock	189–212

"At 140 feet no clay, struck a bowlder and were obliged to shoot the well to get it out of the way, as it jammed the drilling at the end of casing. At 292 feet a sand pocket was struck. When the sand had been pumped out the cavity was filled with cement and the drilling continued. Work was started on August 31, 1897 and stopped December 21, 1898."

[a] Am. Nat., vol. 2, 1869, p. 335.

[b] Merchants' Association report on water supply of the city of New York, 1900, p. 181.



PLAN AND LONGITUDINAL SECTION OF STRATA ENCOUNTERED IN THE SOUTH BROOKLYN SEWER TUNNEL.

By Isaiah Bowman, from personal examination and notes furnished by J. C. Meem, C. E.

7. This well is about 10 feet above low tide and was completed in November, 1903. It is entirely in sand and gravel. At 50 feet clay was encountered, below which the driller stated it was useless to look for water in this vicinity. The clay suggests the Sankaty, and it is supposed that the underlying Jameco does not yield potable water at this point, because of the removal of the clay covering in the upper bay.

10. Q. M. Gen. C. F. Humphrey reports: At Governors Island an 8-inch well was recently sunk to a depth of 1,822 feet 6 inches. At 1,175 feet a flow of 15 gallons per minute was obtained. By torpedoing the well the flow was increased to about 18 gallons per minute. The water was salty and chemical analysis pronounced it unfit for drinking purposes.

The following samples have been received from this well:

Record of United States Army well on Governors Island, New York.

	Feet.
1. Red clay, with bowlders	13
2–4. Red clay; no bowlders	44–55
5. Very fine, gray, micaceous, silty clay	60
6. Dark multicolored gravel, with fragments of Recent shells	70
7–8. Disintegrated micaceous rock, with fragments of Recent shells	73–87
9. Highly micaceous schist or diorite, thought by Mr. E. C. Eckel, of this Survey, to resemble the Harrison diorite	87–1,700

11. *Record of well on Ellis Island, New York.*

	Feet.
1. Sand and gravel	0–35
2. Rock; trap and gneiss	35–1,400

12. Samples and record in the Long Island Historical Museum show:

Record of Long Island Railroad well in Brooklyn, N. Y.

	Feet.
1. Sand, gravel, clay, etc	0–88
2. Micaceous gneiss (possibly Harrison diorite—Eckel)	88–120

13. See Pls. XXVI, XXVII.

16. The following analysis has been made by the Brooklyn health department:

Analysis of well water at Gravesend pumping station.

	Parts per million.
Total solids	127.00
Loss on ignition	27.00
Free ammonia	.002
Albuminoid ammonia	.000
Chlorine as chlorides	12.50
Sodium chloride	20.60
Nitrogen as nitrates	5.76
Nitrogen as nitrites	None.
Total hardness	76.00
Permanent hardness	65.50

18. Mr. L. B. Ward gives the following data regarding this company: "This tract of 90 acres, located in the Thirtieth Ward, between Fifteenth and Eighteenth avenues, and Fifty-third and Sixtieth streets, has an independent water service, with 1.7 mile of distributing pipes and one pumping station located at Seventeenth avenue and Sixtieth street, supplied from a single well."

23. Temperature 52° to 53°. Water used for cooling and manufacturing.

17116—No. 44—06——12

Sanitary analysis of water from well at Eighth avenue and Eighteenth street, Brooklyn.

[Analyst not reported.]

	Parts per million.
Total solids	376.04
Loss on ignition (slight charring)	84.80
Chlorine	30.02
Nitrogen of free ammonia	.05
Nitrogen of albuminoid ammonia	.03
Nitrogen of nitrite	.05
Nitrogen of nitrate	12.07
Temporary hardness	87.28
Permanent hardness	55.84
Total hardness	143.12
Iron	Very faint trace.

Samples received from Mr. R. A. Ward, treasurer, show the following section:

Record of well at Eighth avenue and Eighteenth street, Brooklyn.

Wisconsin till:	Feet.
1. Reddish bowlder clay	5
2. Fine to coarse silty sand with a little gravel	15
3. Same, but much cleaner; note on samples says, "Struck first water, which yielded 3 gallons per minute"	25
Wisconsin and Tisbury:	
4–5. Reddish-brown bowlder clay	35–45
6–14. Clean, dark-colored, reddish-brown glacial sand and gravel	55–135

25. Sample preserved in Mr. Gregory's office dated April 24, 1894, and marked "141 feet; 46 gallons per minute" is a mixture of sand and coarse gravel with much glacial material. It is believed to represent the Jameco gravels. The Tartar Chemical Company report that the water falls to 14 feet when the well is pumped. Temperature 54°.

Analysis of unfiltered well water from Ninth street and Gowanus Canal, Brooklyn.

[Water taken February 20, 1893.]

Evaporated, 4 liters.	Parts per million.
Total solids	225
SiO_2	19
CaO	47
MgO	14

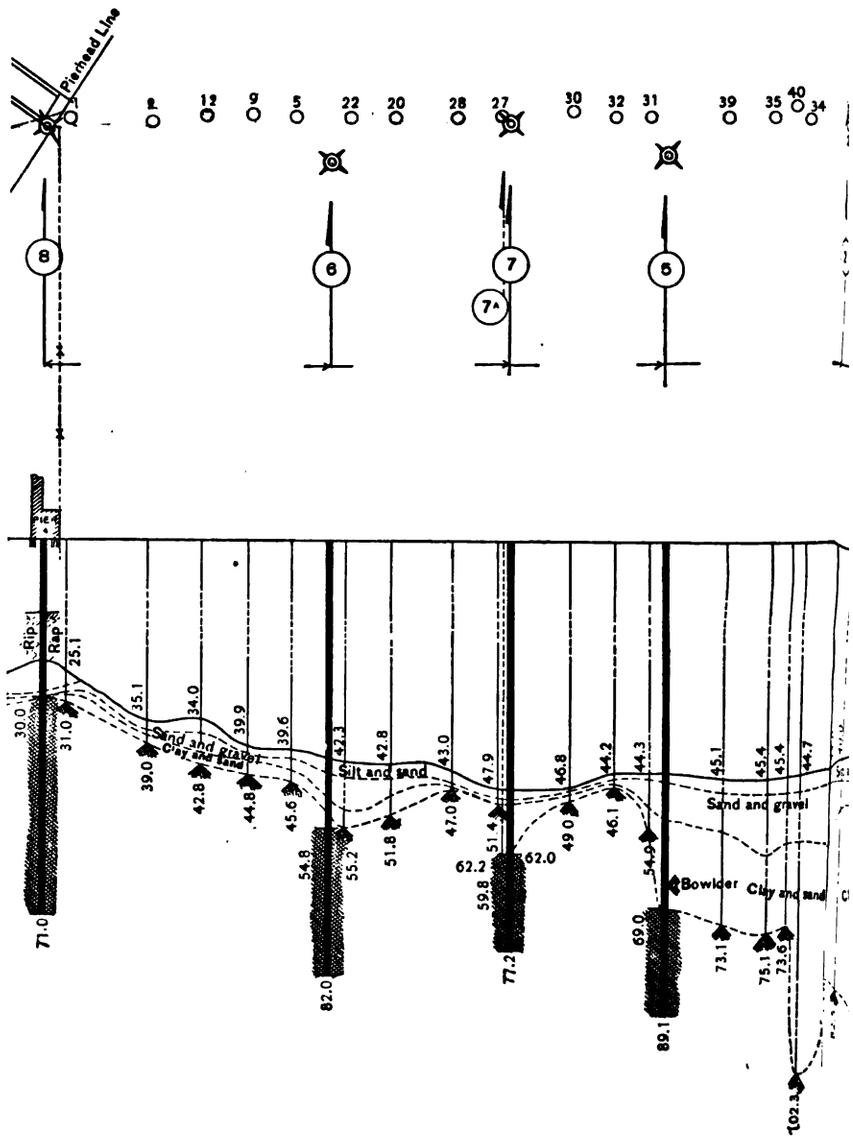
Traces of $FeAl_2O_3$.

Analysis of filtered well water from Ninth street and Gowanus Canal, Brooklyn.

[Water taken February 23, 1893.]

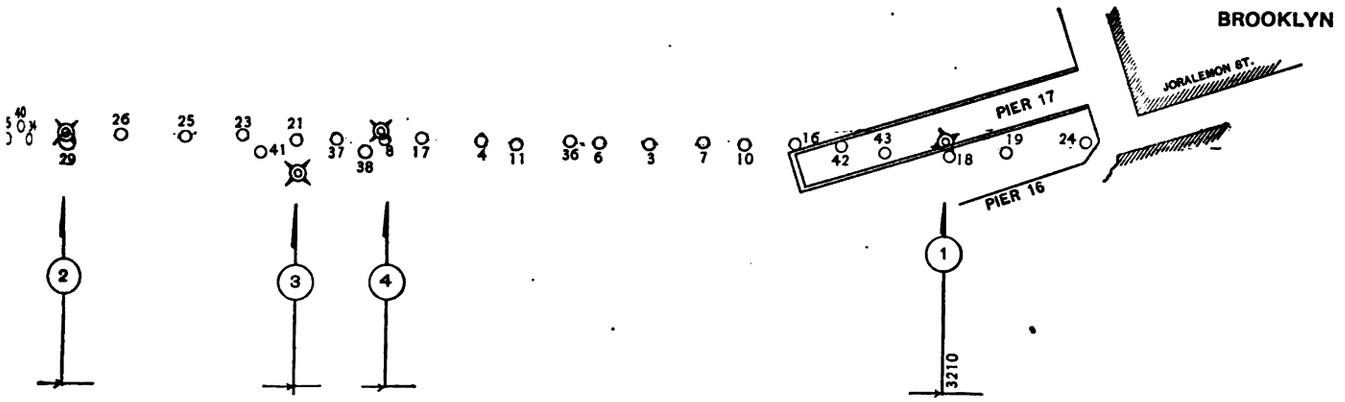
Evaporated, 7 liters.	Parts per million.
Total solids	171.0
SiO_2	19.4
CaO	46.8
MgO	14.8

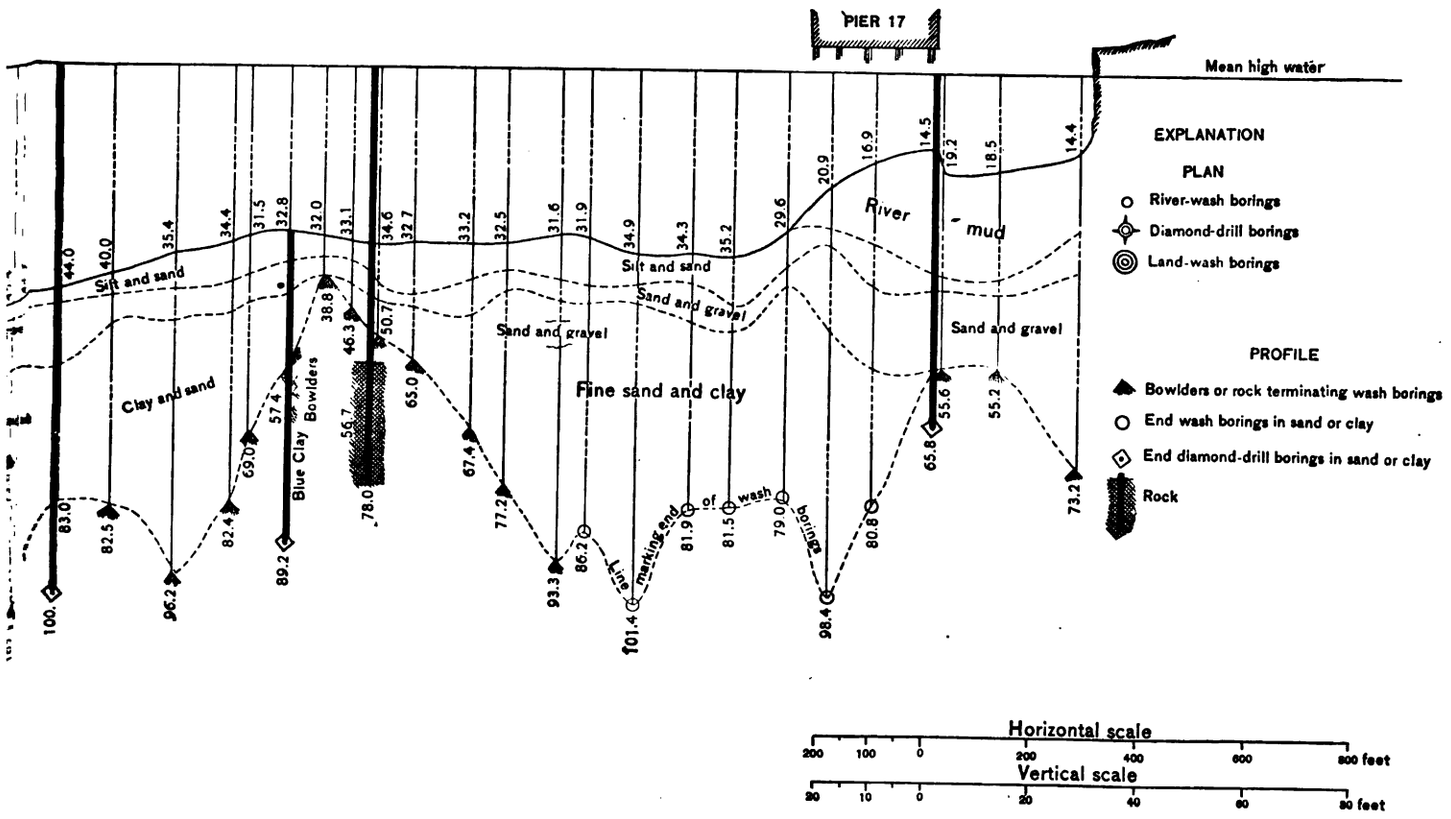
E A S T



TEST BORINGS OF RAPID TRANSIT RAILROAD COMMISSION

R I V E R





ROSS EAST RIVER.

Analysis of well water from Ninth street and Gowanus Canal, Brooklyn.

[Analysis by Charles L. Bauer, Springfield, Ohio, September 26, 1896.]

	Parts per million.
Calcium sulphate	46.3
Calcium carbonate	.0
Magnesium sulphate	49.6
Magnesium carbonate	117.3
Sodium chloride	26.2
Iron	.0
Volatile and organic	171.0
Total solids	410.4

Remarks: Odorless and clear.

Analysis of well water from Ninth street and Gowanus Canal, Brooklyn.

Analysis by bureau of chemistry, board of health, Brooklyn, September 16, 1897; G. J. Volckening, chief chemist; H. W. Walker, assistant chemist.]

	Parts per million.
Chlorine in chlorides	47.02
Equivalent to sodium chloride	77.50
Phosphates	.00
Nitrogen in nitrates and nitrites	16.90
Free ammonia	.00
Albuminoid ammonia	.00
Hardness equivalent to carbonate of lime (before boiling)	197.5
Hardness equivalent to carbonate of lime (after boiling)	197.5
Organic and volatile	145.3
Mineral matter	384.7
Total solids by evaporation	530.1

Analysis of well water from Ninth street and Gowanus Canal, Brooklyn.

[Analysis by Pittsburg Filter Manufacturing Company, Pittsburg, March 20, 1903; F. T. Aschman, chemist.]

	Parts per million.
Sodium chloride	58.0
Calcium sulphate	100.0
Calcium carbonate	80.4
Magnesium carbonate	57.8
Iron and aluminum oxides	5.8
Silica	19.0
Organic and volatile matters	Traces.
Total solids	321.0
Carbon dioxide	67.8

Sample clear.

27. Seventeen test borings were sunk at this point: No. 1, 110 feet north of Third avenue and Third street; Nos. 2–9, at intervals of 50 feet west; Nos. 10–16, bordering Third street, at intervals of 50 feet east toward Third avenue; No. 17, opposite No. 2. The following sections may be taken as typical:

Record of Transit Development Company's test boring No. 3 near Third avenue and Third street, Brooklyn.

	Feet.
1. Light-yellow sand filling	0–12
2. Ash and cinder filling	12–30
3. Gray silt	20–40
4. Very fine to medium light-gray sand	40–50

Record of Transit Development Company's test boring No. 9 near Third avenue and Third street, Brooklyn.

	Feet.
1. Ash filling	0–12
2. Gray silt	12–22
3. Medium light-gray sand containing muscovite and a considerable percentage of erratic material	22–24
4. Light-brown sand, gradually becoming coarser and with an increasing percentage of erratic material	24–35

Record of Transit Development Company's test boring No. 13 near Third avenue and Third street, Brooklyn.

	Feet.
1. Ash filling	0– 7
2. Gray silt	7–15
3. Coarse light-gray sand with a high percentage of erratics	15–20
4. Gray silt	20–27
5. Transition from silt to sand	27–32
6. Medium-brown sand with some erratics	32–40

Record of Transit Development Company's test boring No. 16 near Third avenue and Third street, Brooklyn.

	Feet.
1. Light-brown sand with erratic material between 5 and 10, and fine sand between 10 and 15	0–15
2. Coarse sand with erratic material	15–20
3. Very dark silt	20–32
4. Transition material, silt to fine sand	32–35
5. Fine to medium dark-gray sand with a considerable amount of erratic material	35–42

28. *Record of well on Third avenue between Degraw and Douglas streets, Brooklyn.*

	Feet.
Recent:	
1. Filled ground	0–30
2. Silty clay	30–35
Recent?:	
3. Blue clay	35–40
Wisconsin and Tisbury?:	
4. Clay and sand	40–45
5. Sand and gravel	45–77
6. Quartz sand	77–85

29. *Record of well on Dean street near Vanderbilt avenue, Brooklyn.*

	Feet.
Wisconsin:	
1. Gray sand and stones, large bowlders	8–56
Wisconsin and Tisbury?:	
2. Brown sand and bowlders	56–81
3. Coarse brown sand (water at 81 feet)	81–98

Mr. Corwin adds: "Nearly always we get water in brown sand—pepper and salt mixture—sometimes in yellow coarse sand; never, or hardly ever, in white sand."

30. A sample from this well preserved by Mr. Gregory, and marked 217 feet, is a coarse, multicolored, glacial gravel, similar to the Jameco gravel in the Brooklyn test wells.

Record of well at St. Marks and Grand avenues, Brooklyn.

	Feet.
1. Dug well	0–100
2. Sand, gravel, and clay	100–331
3. Granite rock	331–

FULTON

GALLATIN

8

12

23

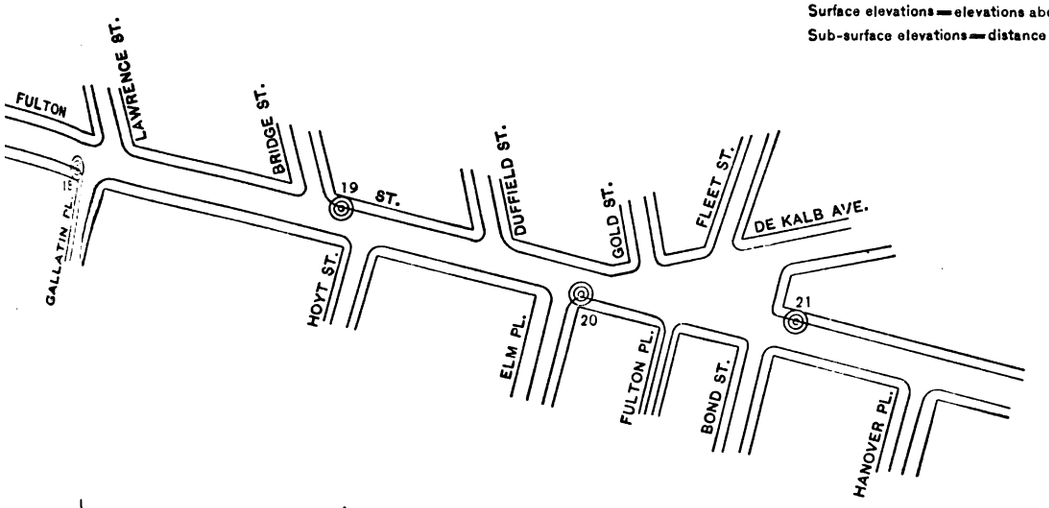
26

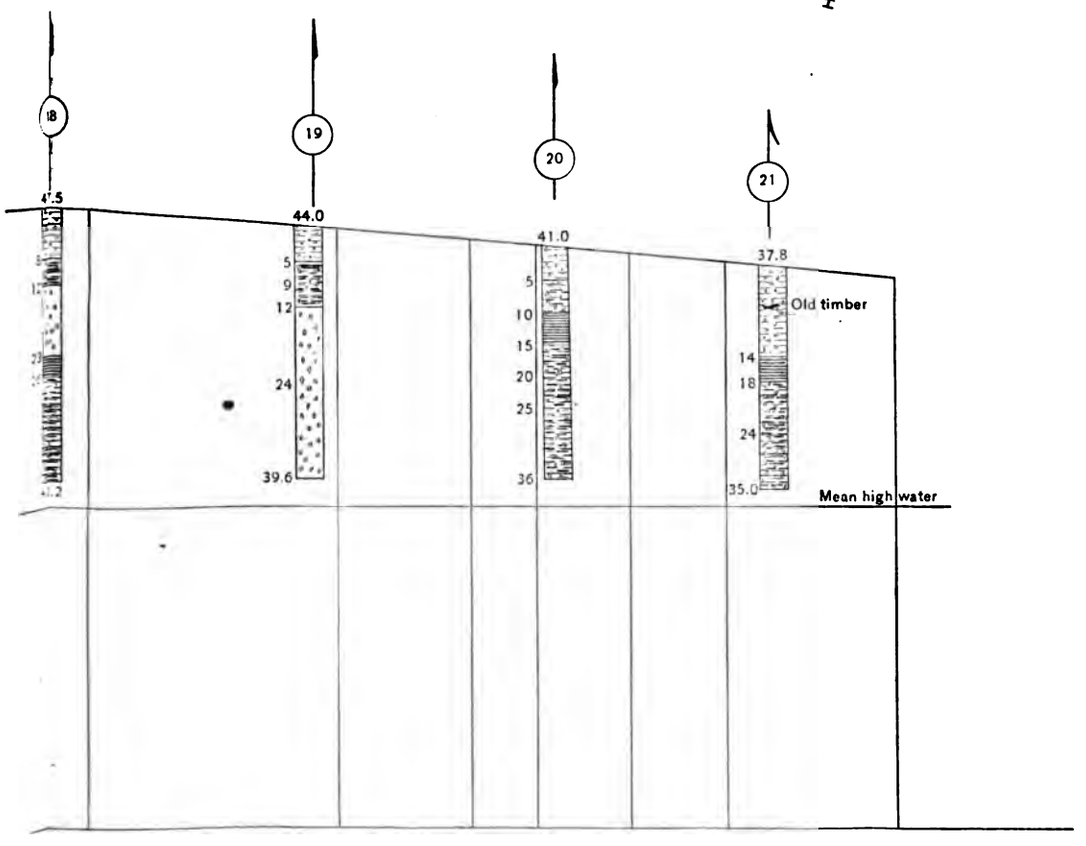
KLY

Horizontal scale
200 100 0 200 400 600 800 feet

Vertical scale
20 10 0 20 40 60 80 feet

Surface elevations = elevations above mean high water
Sub-surface elevations = distance below surface





EXPLANATION

1 Top soil of clay, sand, gravel, etc.
2 Sand, clay, and gravel
3 Sand and gravel with trace clay
4 Sand and gravel
5 Sand and clay
6 Sand with trace clay
7 Hardpan
8 River mud
9 Hardpan and clay
10 Foundations
11 Sand
12 Clay
13 Bowlders

UNIV. OF MICH.

L. L. POATES ENGR'G CO., N.Y.

N.

31. *Record of well at Lewis and De Kalb avenues, Brooklyn.*

	Feet.
1. Dug well	0– 63
Tisbury?:	
2. Light-gray sand and stones	63– 91
3. Coarse gray and white sand	91–101

33. A sample preserved by Mr. Gregory, marked "125–138 feet," is a highly erratic glacial gravel.

35. *Record of well at Forest street and Evergreen avenue, Brooklyn.*

	Feet.
Wisconsin:	
1. Loam and bowlders	0– 23
Wisconsin and Tisbury:	
2. Yellow gravel and sand	23– 63
3. Yellow gravel with water	63–105
Sankaty or Cretaceous:	
4. Blue clay	105–275

37. *Record of well at Bartlett street and Harrison avenue, Brooklyn.*

	Feet.
1. Old well	0– 60
Tisbury?:	
2. Coarse sand, water-bearing	60– 65
Sankaty:	
3. Red clay with an occasional large bowlder	65–150
Jameco:	
4. Coarse red sand, water-bearing	150–165

38. *Record of well at Bartlett street and Flushing avenue, Brooklyn.*

	Feet.
Recent:	
1. Miscellaneous filling down to bottom of old creek	0– 6
Wisconsin and Tisbury:	
2. Loam, sand, and gravel	6– 37
3. Sand and gravel, water-bearing	37– 45
Sankaty:	
4. Interstratifications of clay and fine sand and gravel	45–139
Jameco:	
5. Water-bearing stratum of coarse yellow sand	139–176

The samples of the material encountered in this well, which were obtained through the courtesy of Mr E. L. Heusner, chief engineer, show the following section:

Record of well at Bartlett street and Flushing avenue, Brooklyn.

	Feet.
Recent:	
1. Filled ground	0– 8
2. Black marsh mud	8– 9
3. Blue clay	9– 15
Wisconsin and Tisbury *t*.	
4. Light, yellowish brown, sandy clay at	19
5. Bluish gray, rather pure, clay at	26
6. Highly erratic glacial gravel	31– 36
7–9. Medium sand, the particles being uniform in size, the composition very similar to No. 6	36– 62
10. Erratic gravel mixed with gray clay	62– 73
11. Coarse glacial sand	73– 81
Sankaty:	
12. Bluish gray, impure, sandy clay	87– 93

Sankaty—Continued.	Feet.
13. Yellowish gray sand mixed with clay	93–108
14. Clean, light-brown, medium, erratic sand	108–122
15. Bluish gray sandy clay	122–124
16. Yellowish brown medium sand, slightly clayey	124–127
Jameco:	
17. Yellowish brown, coarse, clayey sand	127–134
18–19. Very coarse slightly clayey sand, having a dark-yellow color	134–145
20–22. Reddish yellow, extremely coarse sand with erratic material as in the preceding samples	145–174
23. Similar to the preceding, but much coarser and with erratic material more abundant	174–175

Mr. Heusner states that the first wells which were used on this property by the chemical company were 30 feet deep. These wells were successively deepened to 40, 50, and 70 feet, and finally it became necessary to sink the deep wells above described. The water from the deep wells rises to within 7 or 8 feet of the surface, or to the surface of the original ground before this section was built up by filling. The capacity of this well is 500,000 gallons in twenty-four hours, the well being pumped steadily the year round, night and day.

40. *Record of well at 20 to 34 Ryerson street, Brooklyn.*

	Feet.
1. Filling	0– 8
2. Sand, stones, and little clay	8–32
3. Fine sand and clay	32–84
4. Hell Gate rock	84–

41. *Record of well at 163 Carlton avenue, Brooklyn.*

Wisconsin:	Feet.
1. Dug well	0–50
2. Bowlders	50–60
Wisconsin and Tisbury:	
3. Sand	60–90

42. Mather gives the following section of a well sunk for Mr. Johnson in Brooklyn between "Wallabout and Guanus" in April, 1811:

Record of well between Wallabout and Gowanus, Brooklyn.

	Feet.
1. Sandy loam	0–3
2. Hard concreted clay, sand, and stones colored with iron and requiring a pick to dig; composed of gneiss, hornblende, and brittle slate	3–18
3. Loose gravel and grayish sand, with thin streaks of gravel, the gravel of quartz, bassanite, breccias, mica slate, and red sandstone	18–38
4. Alternating layers of 2 or 3 feet of sand and gravel, containing coarse green soapstone in addition to the materials of No. 3	38–55
5. Sand and gravel in alternating layers; the gravel beds contain sea shells, mostly clams and oysters, but the sand none	55–84

43. According to Hollick,[a] this is the location of the well from which the *Exogyra costata*, reported by Redfield[b] and Cozzens,[c] was taken at a depth of 65 feet.

45. A drawing in the museum of the Long Island Historical Society, by C. M. Jacobs, consulting engineer, gives the following section at the east tower of the Brooklyn Bridge:

[a] Trans. New York Acad. of Sci., vol. 12, 1893, p. 225.
[b] Am. Jour. Sci., 1st ser., vol. 45, 1843, p. 156.
[c] A Geological History of Manhattan Island, 1843, p. 51.

Record of excavation for east tower of Brooklyn Bridge, Brooklyn.

	Feet.
1. Water	0 –10
2. Gravel and bowlders	10 –12
3. Hardpan; concrete and serpentine rock	12 –23.6
4. Bowlders and sand; a trap bowlder	23.6–32
5. Sand	32 –34.8
6. Sand, gravel, and clay	34.8–49
7. Reddish clay	49 –50
8. Very compact sand, gravel, and clay, mixed with trap	50 –89
9. Rock	89 –

46. *Record of well at Pear and Front streets, Brooklyn.*

Wisconsin and Tisbury:	Feet.
1. Sand and bowlders	0–21
2. Coarse brown sand	21–60
3. Fine red sand	60–

47. Mr. Ingalls, of John W. Masury & Son, reports two 5-inch and five 6-inch wells drilled between 1877 and 1902. He gives the following description of the locality: "After a few feet of loose earth there is clay, very hard, from 27 to 33 feet, where we get gravel and clay to 40 feet. The lower clay and gravel are filled with hard bowlders (probably glacial, as every well in this end of Long Island has shown these to be widely distributed). Below 40 feet the sand becomes finer and is water bearing. Our wells give a good supply at 53 feet, which is not much increased at 75. Below 50 feet is clear fine sand, with bowlders in some places, extending to about 90 feet, where hard blue clay is reached.

"An interesting feature of our wells is the rapid corrosion of brass strainers. The metal loses the zinc. A corroded and useless strainer showed 65 per cent copper and 35 per cent zinc in the perfect spots and over 99 per cent copper in the corroded parts, which were chiefly at the bottom, the top being in perfect condition. The water is not acid except with CO_2, and the prevailing opinion is that the action is electrolytic, though this has not been proved.

"The 75-foot well has a casing of 59 feet of 8-inch pipe, with a 16-foot brass strainer, 6 inches in diameter, extending below and connected with a 6-inch iron pipe inside the casing. This well when first completed gave 225 gallons per minute with a centrifugal test pump.

"The supply is all right, but the strainers give out, the pump fills with sand, and we have to keep putting down new wells and strainers every year or two.

"Changing the position of the wells only 25 or 50 feet seems to make a difference in durability. Water is good, but hard. It is used principally for cooling purposes."

Mr. Jamieson, of Arbuckle Brothers, reports that a sample taken from this well November, 1899, showed 1,662.5 parts of chlorine per million.

48. Mr. H. S. Stewart reports: "Well No. 1 was about 800 feet deep. We struck what I would call trap rock at 97 feet—until that depth it was quicksand or gravel and bowlders. We shut that off with 18-inch pipe. From 97 feet to 800 feet it was trap rock standing on edge all the way and full of crevices, making it very hard to keep a straight hole. We abandoned that well at about 800 feet, and started No. 2 about 500 feet away. We encountered the same formation in this well to a depth of about 93 feet and then struck the same kind of trap rock, which continued for about 800 feet. Below this the rock lay level and we had no more trouble in keeping a straight hole. This rock was granite, some dark and some red. It would change in color sometimes in 20 feet and sometimes run in the same color for 30 feet. This well was drilled to a depth of 2,148 feet. There was water in the gravel above the trap rock, but it was not the quality of water wanted. We cased it off and went on down. There was no water in the granite nor trap rock—it was too hard to contain water. The well was then abandoned at Mr. Arbuckle's request."

Water from a depth of 51 feet showed 560 parts of chlorine per million.

51. *Record of well at Brooklyn Navy-Yard, Brooklyn.*

	Feet.
1. Filled ground	0– 15
2. Stiff blue clay	15– 24
3. Hardpan	24– 26
4. Blue clay and gravel	26– 30
5. Hard pan	30– 38
6. Reddish blue clay	38– 42
7. Sand	42– 48
8. Blue clay	48– 60
9. Gravel and hardpan	60– 73
10. Stiff blue clay	73– 84
11. Bowlders and gravel; water brackish and filthy	84–103
12. Brown-yellow granite	103–122
13. White granite	122–129
14. Gray granite	129–144
15. Bluish granite	144–156
16. Gray mica-schist	156–168
17. Darker schist	168–172
18. White schist	172–185
19. Black schist	185–227
20. White granite	227–246
21. Gray granite	246–259
22. White granite, yielding good clear water, which dissolved scale in boilers, and contained some soda	259–275
23. Reddish brown granite	275–288
24. Black granite, more water	288–296
25. White granite	296–312
26. Black granite	312–316

Mr. Wankel adds: "All the water above the rock is of very poor quality. The water from the rock rose to within 50 feet of the surface. A supply of 60 gallons was obtained at 275 feet and 80 gallons at 296. This well was put down in the granite building which inclosed the large pumping engine."

The civil engineer at the navy-yard reports in a letter transmitted by the Secretary of the Navy: "At a point marked 2 on the map a well was driven to a depth now unknown, but from such sources as are now available, this depth is supposed to have been about 120 feet. The water was found to be brackish and the well was abandoned." From the location given, this is clearly the well described by Mr. Wankel.

52. Mr. Wankel says: "This well furnished about 60 gallons per minute of very good clear water from the rock at about 190 feet. It dissolved scale in boilers, and contained some soda and carbonic-acid gas."

Record of well at Brooklyn Navy-Yard, Brooklyn.

	Feet.
1. Filled ground	0– 11
2. Marsh	11– 23
3. Blue clay	23– 26
4. Fine white sand	26– 29
5. Coarse sand	29– 35
6. Hardpan	35– 51
7. Mixed sand	51– 56
8. Yellow water sand	56– 62
9. Brown water sand	62– 74
10. Coarse brown water sand	74– 83
11. Gray sand	83– 85
12. Beach sand	85– 88
13. Blue clay	88– 93
14. Sand and gravel, "brackish water"	93– 96
15. Blue granite	96–220

The civil engineer of the navy-yard reports: "Only one well was a success. It still exists and it is stated that the depth is about 216 feet, and that rock was struck at a depth of 96 feet. From measurements made recently the depth of this well is found to be 205.6 feet from the top of the casing."

53. *Record of well at Brooklyn Navy-Yard, Brooklyn.*

	Feet.
1. Filled ground	0– 9
2. Stiff blue clay	9– 35
3. Hardpan	35– 46
4. Sandy yellow clay	46– 54
5. Hardpan	54– 66
6. Sand and water	66– 74
7. Hardpan	74– 80
8. Fine pasty sand	80– 98
9. Granite bowlders	98–101
10. Flint granite	101–108

54. The various depths given in the following record are referred to the top of the coping of dry docks 2 and 3:

Record of well at Brooklyn Navy-Yard, Brooklyn.

	Feet.
1. Filling	0 – 9.5
2. Bluish clay-like materials mixed with shells	9.5–25
3. Peat	25 26
4. Fine light clayey sand	26 28
5. Fine iron-colored sand	28 31
6. Fine drab sand	31 33
7. Fine dark-drab sand	33 39

55. The original record of this well, published by E. Lewis, jr., in the Popular Science Monthly, volume 10, 1877, page 443, is as follows:

Record of well at 556 Kent avenue, Brooklyn.

	Feet.
1. Surface gravel	0 – 30
2. Quicksand	30 – 32
3. Bowlder drift	32 –102
4. Clay	102 –129
5. Oyster shells	129 –129.5
6. Coarse sand	129.5–

Samples preserved in the museum of the Long Island Historical Society show the following section:

Record of well at 556 Kent avenue, Brooklyn.

	Feet.
1. Bowlder clay	0–70
2. Water-worn fragments of shells apparently Recent from a layer at a depth of	129.5
3. Medium white sand, not clearly glacial. Depth not given, marked "water-bearing stratum."	

An error has apparently been made in transcribing the record, which is published by Merrill (Annals N. Y. Acad. Sci., vol. 3, p. 346) and reprinted by Darton (Bull. U. S. Geol. Survey No. 138, 1896, p. 34).

Mr. Fred S. Benson, chief engineer of the eastern division of the Brooklyn Union Gas Company, reports under date of November 30, 1903: "The well you refer to as being 129 feet 6 inches deep was put down by the Nassau Gaslight Company in 1873 or 1874. The well was located at Kent avenue and Cross street, Brooklyn. Its yield when first tested was 500 gallons per minute. We have since put down two other pipes in the same excavation, but the quantity of water has diminished yearly. I might add that the pipes have been drawn up to a depth of 85 feet from the ground level, that being the depth from which the maximum quantity was obtained in 1902."

60. Mr. C. D. Corwin reports the following section:

Record of well at Bushwick and Meserole avenues, Brooklyn.

	Feet.
1. Yellow clay and stones	0–49
2. Gray sand	49–55
3. Fine sand and mica	55–63
4. Yellow clay, with quartzite, slate, conglomerate, and feldspar pebbles	63–101
5. Water-bearing gray sand and gravel	101–117
6. Blue clay (not passed through)	117–120

62. Phillips and Worthington report the following section:

Record of well on Ten Eyck street, between Bushwick avenue and Florence street, Brooklyn.

	Feet.
Wisconsin:	
1. Interlying strata of clay, sand, and gravel (very heavily bedded with bowlders)	0–52
Tisbury?:	
2. Coarse yellow sand and gravel	52–75
Sankaty?:	
3. Blue clay	75–100
Jameco? and Cretaceous:	
4. Beach sand	100–240

This well was abandoned and a new one sunk, which obtained its supply from the water-bearing strata between 52 and 75 feet.

Mr. I. H. Ford gives the following section:

Record of well on Ten Eyck street, between Bushwick avenue and Florence street, Brooklyn.

	Feet.
1. Dug well	0–58
Tisbury?:	
2. Water-bearing sand	58–76
Sankaty?:	
3. Reddish-brown clay	76–160

64. These wells are entirely in sand; there is plenty of water, but if too much is drawn, salt water from Newtown Creek comes in. Analysis of the water shows 1,000 parts of chlorine per million.

65. A test well at this point gave the following section:

Record of well at Porter and Maspeth avenues, Brooklyn.

	Feet.
Wisconsin:	
1. Stones and rough material; no sand	0–12
Wisconsin and Tisbury?:	
2. Loam, sand, etc.	12–48
Sankaty?:	
3. Clay having a blue color	48–190
Jameco?:	
4. Water-bearing gravel	190–

A good supply of water is reported from layer 4, but the wells at this point are completed in layer 2.

66. Mr. C. Harty, foreman for I. H. Ford, has kindly furnished the following data of the deep test wells at this point: Diameter, 10 inches, 0–137 feet; 8 inches, 137–200; 6 inches, 200–225.

Record of well at Meeker and Kingsland avenues, Brooklyn.

	Feet.
1. Filled ground	0–5
Wisconsin:	
2. Blue clay with bowlders	5–16
3. Sand and small bowlders with water	16–32

	Feet
Cretaceous ?:	
4. Blue clay	32–72
5. Light-gray clay	72–180
Cretaceous:	
6. Sand—not water bearing	180–180.5
7. Blue clay	180.5–205
8. Light-greenish clay, passing into dark-greenish clay containing small concretionary masses	205–215
9. Yellow and dark-colored sandy clay	215–225
Pre-Cretaceous:	
10. Rock, mica-schist	225–

This well was abandoned and a shallow well sunk near it, which obtained water from the glacial gravels between 28 and 32 feet. The section of this shallower well is:

Record of well at Meeker and Kingsland avenues, Brooklyn.

	Feet.
Wisconsin:	
1. Blue clay; no stone	0–28
2. Reddish-brown glacial sand and gravel	28–32
Cretaceous ?:	
3. Light-gray clay	32–40

67. *Record of well on Meeker avenue, between North Moore and Monitor streets, Brooklyn.*

	Feet.
1. Yellow clay and stones	0–10
2. Gray sand and stones	10–18
3. Nearly all stones, very little sand	18–27
4. Stones and gray sand	27–32
5. Stones and red sand	32–40
6. Fine gray sand	40–43
7. Very tough light dry clay	43–47
8. Fine sand with conglomerate, quartz, feldspar, and jasper pebbles	47–54
9. Coarse gray sand with fresh water	54–55.5
10. Yellow clay	55.5–60
11. Blue clay	60–63
12. Gray sand and gravel; good water-bearing stratum	63–70
13. Fine sand	70–73

71. Mr. F. P. Rust, manager of the Rust Well Machinery Company, gives the following record of this well:

Record of well at 99 to 117 North Eleventh street, Brooklyn.

	Feet.
Wisconsin and Tisbury:	
1. Sandy loam and bowlders	0–50
Sankaty ?:	
2. Blue clay	50–70
Jameco ?:	
3. Gravel and bowlders	70–100
Cretaceous ?:	
4. Blue clay	100–125
5. Quicksand	125–132
Pre-Cretaceous:	
6. Light-gray and black granite	132–333

The New York Quinine Chemical Company report a yield of 7,500 gallons per hour. The water level lowers 5 feet on pumping eight hours; temperature of water 65° F.; it contains much lime and magnesia and is not used for drinking.

72. Mr. H. L. Pratt of the Standard Oil Company gives the following information: "About twenty-five years ago an attempt was made to drive a well at this point, but after going to the depth of 200 feet without getting any water the well was abandoned on account of a ledge of rock."

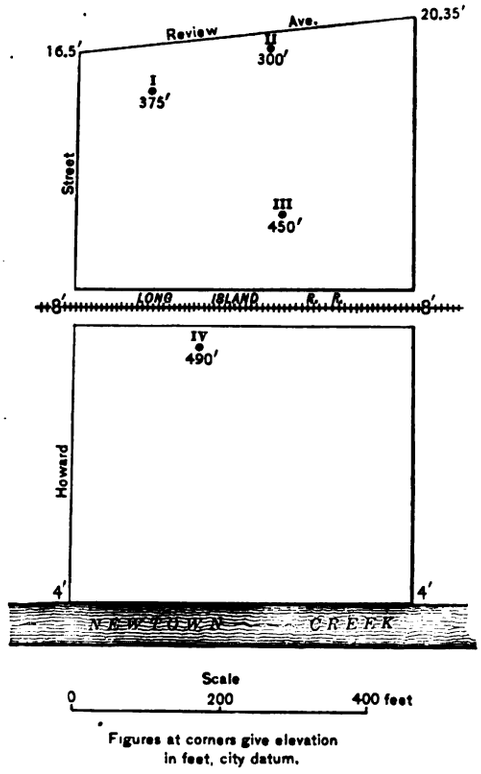


FIG. 61.—Sketch map showing location of deep wells of the Fleischmann Manufacturing Company at Long Island City.

75. The following data have been furnished by Mr. Jacob Blumer:

"We drove at least 25 shallow wells to a depth of from 60 to 70 feet. In the depth mentioned, we went through sand and gravel only and never struck rock. All the wells furnished water, but of late years the levels became lower. Twenty years ago the levels stood 15 to 16 feet from the surface, and in the last wells, made in 1897, it was as low as 38 to 40 feet. As for the amount of water furnished, I can only give you figures for the three wells which were made in 1897. These were made by sinking a pit 7 by 9 feet to a depth of 36 or 40 feet, and then we drove 20 to 25 feet of 6-inch pipe with a perforated strainer at the end through sand and gravel. The pump was at the bottom of the pit and each well was good for 200 gallons per minute. The water in these wells was clear and cold, but exposed to the air became yellowish. Hydroxide of iron precipitated in the water; this was quite troublesome in our pipe lines. After about three years a 3-inch pipe would be nearly filled up solid with the precipitate.

"We also made four deep wells, the locations of which are shown on the accompanying diagram [fig. 61]. In these we went through 70 to 80 feet of sand and gravel, and in all of them struck rock at 124 feet; the rock was porous but hard. In all wells we found plenty of petrified wood, some black, some yellowish white, like hard maple, and in some of the shallower wells we found petrified fish roe.

"No. 1 deep well was originally 275 feet deep, and yielded 80 to 100 gallons per minute. After No. 3 well was made and operated, the yield of No. 1 diminished; then we drilled to 375 feet, but did not get the water back, and in a few months it had gone out entirely and the well was abandoned.

"No. 2 deep well was 300 feet deep, and yielded 120 to 125 gallons per minute, and kept it up until we closed the works. Level of water in the well when not in operation was 220 feet from the surface.

"No. 3 deep well was 450 feet deep; it yielded 125 gallons as long as we were running the place; level was 250 feet from surface.

"No. 4 deep well was 490 feet deep; it yielded about 10 gallons per minute and was abandoned. The water from all the deep wells was a little brackish—the amount of chloride increasing continuously. I can give you the amount of chlorine for No. 1 well for a period of over three years."

Chlorine in water of Fleischmann deep well No. 1 at Blissville, Long Island City.

	Parts per million.
October 12, 1888	1,902.1
October 17, 1888	2,000.8
December 11, 1888	2,329.5
March 11, 1889	2,556.0
May 29, 1889	2,756.9
June 24, 1889	2,785.4
October 11, 1889	3,064.0
March 5, 1890	3,415.2
December 10, 1890	3,632.2
February 10, 1892	3.984.0

76. A large well at this point, 25 feet in diameter and 50 feet deep, has a number of 6-inch points driven in the bottom of it to a depth of 60 to 70 feet; the water level was originally 5 or 6 feet from the surface of the ground, but is now 60 feet, and the large well, or pit, has been deepened from time to time as the water-level lowered. In the spring of 1903 the large plants across Newtown Creek which have wells in the same stratum closed down, and the water is rapidly rising in the Standard Oil Company well, and threatens to drown out the pumps which are placed in the bottom of the large well. The water is "everything that is bad;" it is used for condensing purposes only.

79. The original record by Lewis is as follows:

Record of well at New Calvary Cemetery, Long Island City.

	Feet.
Pleistocene:	
1. Surface loam and drift	1–139
Raritan:	
2. Greenish earth	139–178
3. White clay with red streaks	178–182
4. Gneiss	182–582

Darton reports the water soft, with only a little lime, magnesia, and chlorine. In the museum of the Long Island Historical Society, the following samples are preserved: (1) Green sandy clay, marked: "39 feet thick at a depth of 139 feet:" (2) mottled red and white clay, "200–204." Of the green sandy clay Merrill says: "The greenish earth was found to be ferruginous, and on treatment with hydrochloric acid left a residue which, under the microscope, was seen to consist of fragments of kaolinized feldspar, with occasional grains of coarse sand."

80. *Record of commission's test well, Long Island City.*

	Feet.
Wisconsin:	
1. Humus-stained loamy sand	0.4– 0.5
2–3. Very fine, light-yellow, clayey silt	1.5– 6.0
4–5. Fine, reddish-yellow, silty sand	7.5–14.0
6. Medium to coarse, clean, dark-brown sand	18.5–19.0
7. Fine, reddish-yellow, silty sand	20.5–21.5
8–10. Dark, grayish-brown sand to small gravel	27.5–38

All samples have a decidedly glacial appearance.

82. *Record of Flower estate well, Long Island City.*

	Feet.
Wisconsin:	
1. Sandy clay	0–90
Tisbury?:	
2. Coarse sand, full of water	90–100
Cretaceous?:	
3. Clay	100–112
4. Rock	112–145

83. *Record of commission's test well., Long Island City.*

	Feet.
1. Humus-stained sandy loam	0 – 0.5
2. Yellow sandy loam	1.5– 2.5
3–10. Fine to medium, reddish-yellow, glacial sand with a little silt	8 –40.0

85. See fig. 62 and Pls. XXVIII–XXXIII.

86. A number of test borings were put down at this point for foundations for an electrical plant. In one well marine shells were found at a depth of about 60 feet; in another water was encountered which flowed 1 foot above the surface; bed rock was reached at different depths, the greatest being 69 feet.

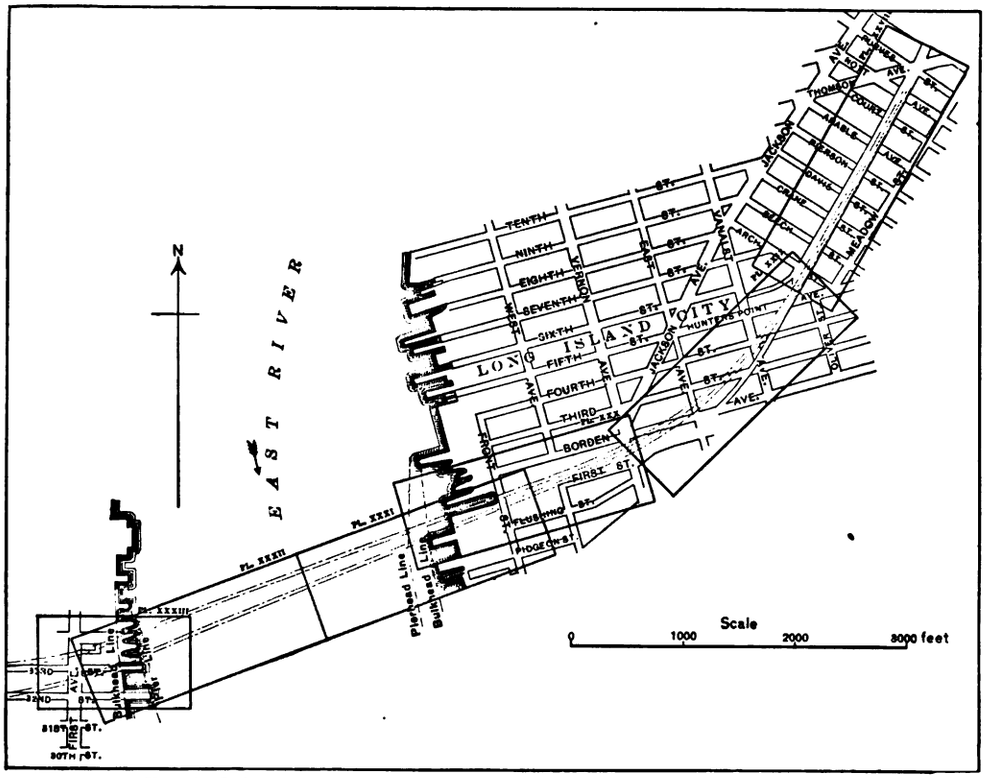


FIG. 62.—Index map showing location of borings represented on Pls. XXVIII–XXXIII.

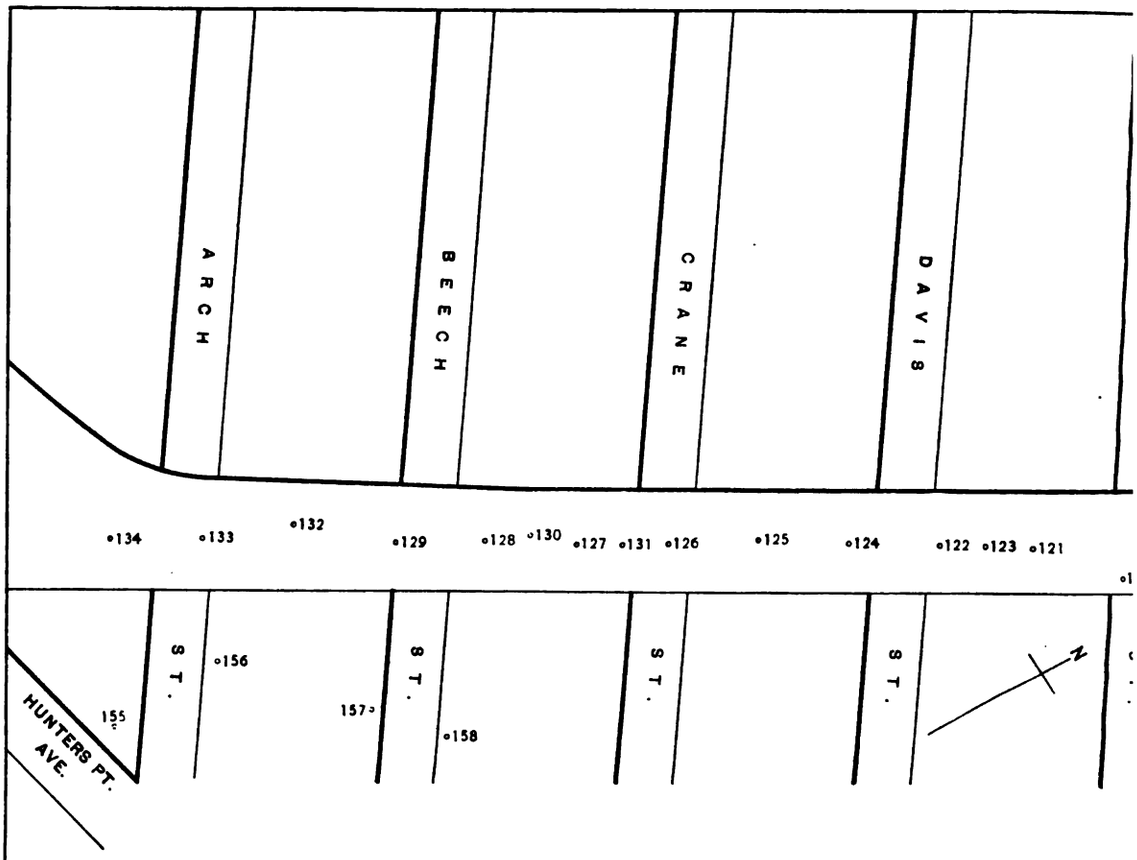
87. *Record of well at Sixth street and West avenue, Long Island City.*

	Feet.
1 Ash and cinder filling	0– 7
2. Fine yellow sand	7– 18
3. Blue mica sand (disintegrated rock)	18– 22
4. Gneiss rock	22–152

Mr. Sweeney reports that the rock in this well dipped at rather a high angle, and that it was very difficult to enter the pipe in the rock. At the last depth given a supply of brackish water was found in a crevice. The granite was of unequal hardness.

88. Water is only slightly brackish, is excellent for boiler use and gang purposes, and contains lime, magnesia, and salt.

U. S. GEOLOGICAL SURVEY



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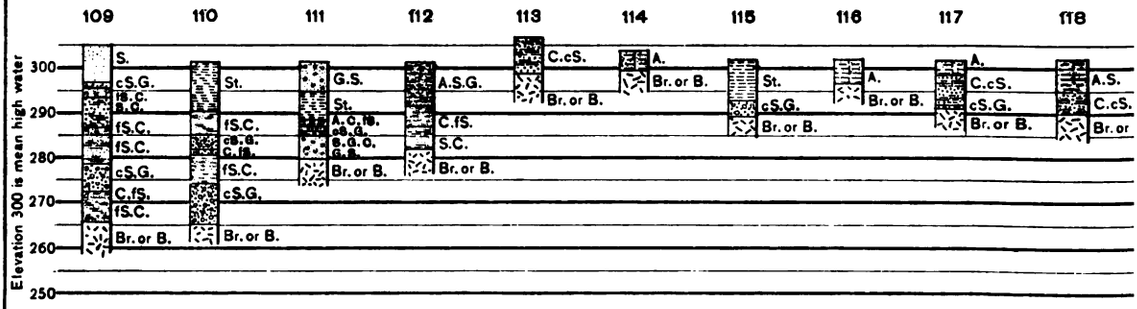
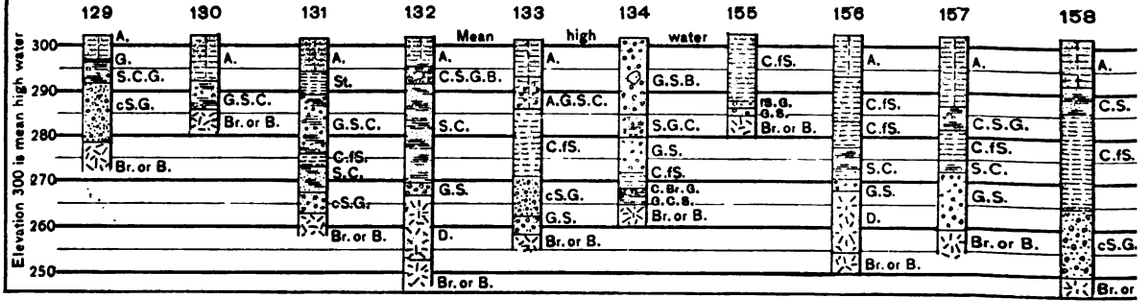


WASH BORINGS



MAP AND DIAGRAM OF BORINGS FOR PENNSYLVANIA, NEW YORK AND LONG IS

89. The elevation of this well is about 8 feet above mean tide.

Record of well at Vernon and Nott avenues, Long Island City.

	Feet.
1. Ash and sand filling	0–14
2. Coarse yellow sand	14–23
3. Blue sand (disintegrated rock)	23–25
4. Gneiss	25–85

91. This well, which is about 5 feet above the adjacent sea marsh, is reported to have passed through nothing but gravel, but a near-by well struck beds of blue clay with but 1 or 2 feet of gravel. Both were test wells put down by the water department of Long Island City.

92. *Record of well at 596 Jackson avenue, Long Island City.*

	Feet.
1. Clayey loam	0–10
2. Sand and gravel	10–16
3. Layer of stones averaging about half the size of paving stones	16–19
4. White clay	19–20
5. Compact mixture of sand and gravel	20–21
6. Black and white gravel	21–25

93. A group of 20 or 30 wells, of which several are flowing; they are so connected that it is impossible to tell which is and which is not flowing. The one nearest the branch is reported to have originally flowed 18 gallons per minute; it flowed July 19, 1903, about one-half gallon per minute from the pipe and 1 or 2 gallons on the outside of the pipe. The Long Island Railroad Company reports one well flowing slightly, but readily pumped down. The water is excellent, but the supply not great.

Analysis of water from well at Jackson avenue and Hill street, Long Island City.

	Parts per million.
Free ammonia	0.091
Albuminoid ammonia	.128
Oxygen consumed	.842
Nitrites	Trace.
Nitrates	.993
Sodium chloride	16.330
Hardness	120
Permanent hardness	50
Temporary hardness	70
Total solids	250

In the near-by well the following section was encountered by Mr. S. H. Allen:

Record of well at Jackson avenue and Hill street, Long Island City.

	Feet.
1. Blue clay	0–31
2. Hard packed gravel with water	31–38

94. *Record of well at Long Island Railroad and Remsen street, Long Island City.*

	Feet.
1. Bowlders and loam	0–40
2. Sand	40–50
3. Rather coarse water-bearing gravel	50–61

95. Mr. Allen states that the well at this point will flow when the near-by waterworks station is not pumping; when it is pumping its maximum capacity the well will lower about 15 feet; it is also affected by the pumping at the ice factory near Jackson and Steinway avenues (No. 98).

96. *Record of well at Buckley street and Middleburg avenue, Long Island City.*

	Feet.
1. Sand	0–12
2. Bowlders	12–19
3. Black and white gravel	19

The bowlders in stratum 2 were so large and numerous at 12 feet that a hole 10 feet square was dug and the bowlders removed; the bowlders varied from 8 to 10 feet in diameter.

98. Mr. S. H. Allen furnishes the following data regarding the six wells which he completed at this point:

Well No. 1: Depth, 66 feet; diameter, 4 inches; depth to water, 3 feet; tested, 48 gallons per minute, full capacity not reached.

Record of well No. 1 at Long Island Railroad and Lowery street, Long Island City.

	Feet.
1. Dark-brown sand	0–15
2. Sand	15–30
3. "Hardpan"	30–35
4. Coarse gravel with water	35–66

Well No. 2: Depth, 97 feet; diameter, 2 inches; depth to water, 5 feet; capacity, 160 gallons per minute. With direct suction the water lowers to 17.9 feet, but will not lower farther.

Well No. 3: Depth, 51 feet; diameter, 4 inches; capacity, 60 gallons per minute.

Well No. 4: Depth, 54 feet; diameter, 2 inches; capacity, 60 gallons per minute.

Well No. 5: Depth, 55 feet; diameter, 3 inches; capacity, unsatisfactory.

Well No. 6: Depth, 66 feet; diameter, 3 inches; capacity, 60 gallons.

Sweeney & Gray completed three wells at this place and report the following typical section:

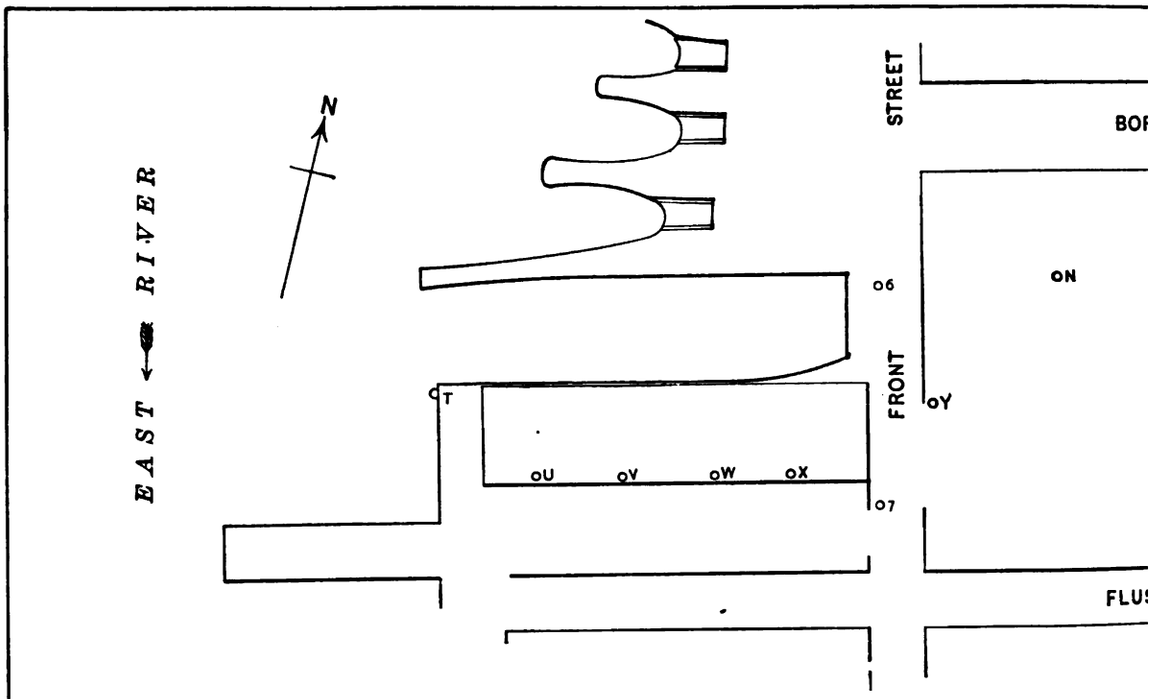
Record of well at Long Island Railroad and Lowery street, Long Island City.

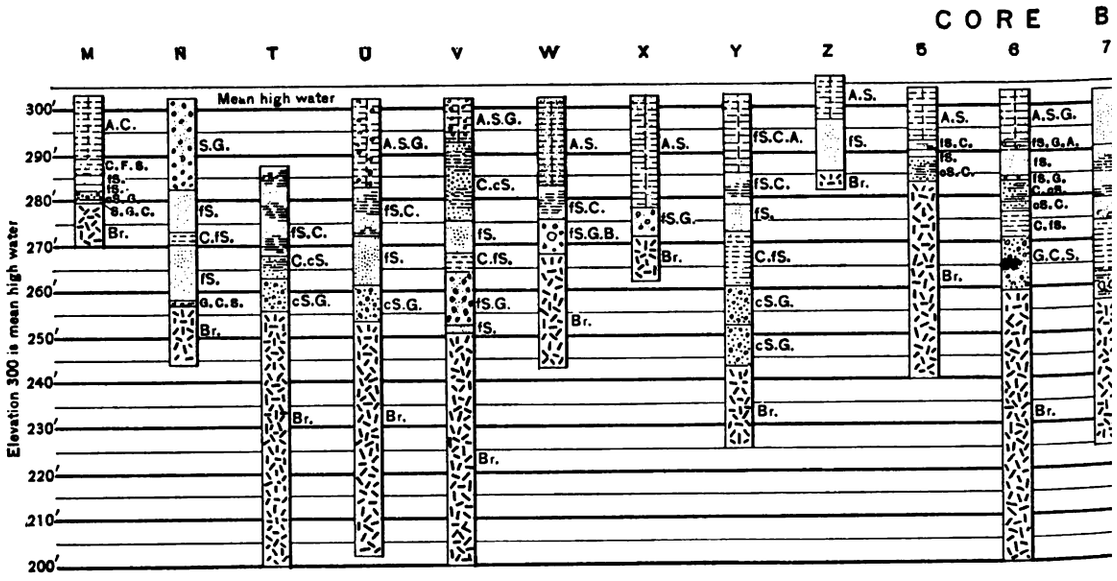
	Feet.
1. Medium red sand	0–20
2. Mixture of red, blue, and white clays	20–23
3. Mixture of sand and gravel cemented with iron	23–30
4. Fine blue, water-bearing sand	30–45
5. Ordinary sand and gravel	45–55
6. Black and white gravel	55–62

99. For records of original wells put down at this station see Pl. XXXIV, which was prepared by Mr. A. S. Farmer from samples. Mr. Farmer has also furnished the following record and samples of the test boring made in connection with a new series of wells which was completed at this point in the spring of 1904:

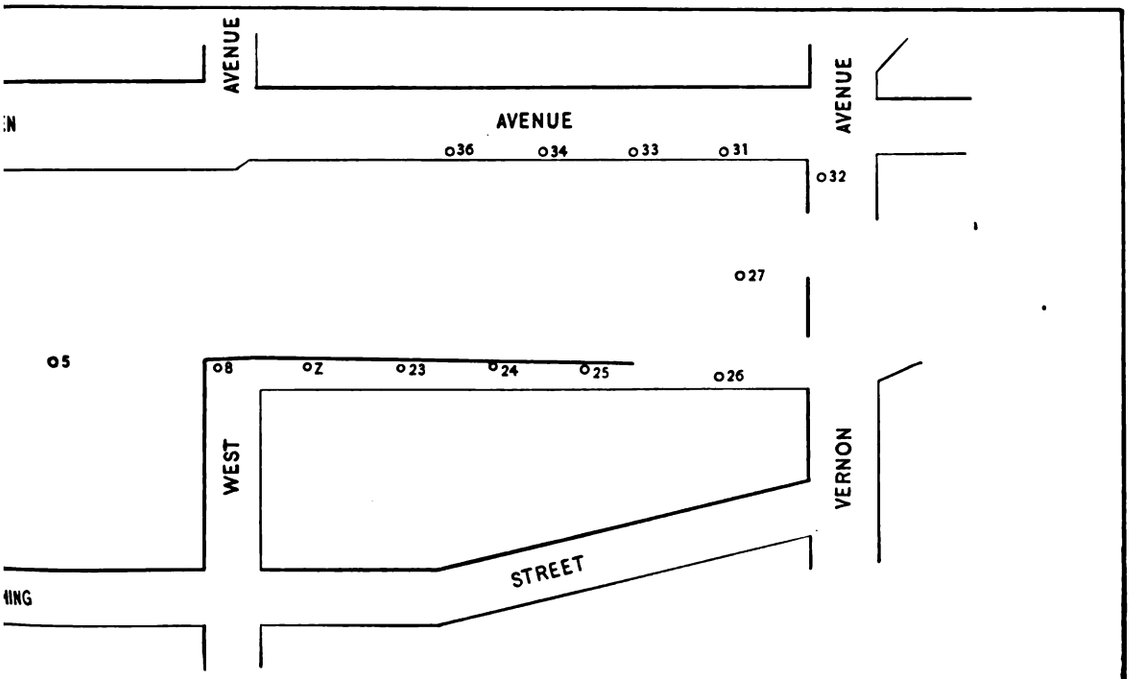
Record of wells at Long Island Railroad and Grove street, Long Island City.

	Feet.
Recent:	
1. Marsh deposits	0– 2
Wisconsin:	
2. Slate-colored clay	2– 7
3. Sand and clay cemented into hardpan	7– 32
4. Water-bearing sand; not a very good water stratum	32– 33
Wisconsin or Tisbury:	
5. Sand and gravel up to one-half inch in diameter cemented into hardpan; very hard to drill	33– 55
6. Reddish brown sand mixed with small gravel	55– 58
Cretaceous (Raritan):	
7. Sand and clay of greenish color; easy to drill; color changing to gray at 85	55– 85
8. White clay (kaolin)	85–110
9. White and greenish clay (not greensand) evidently a rock-weathering product	110–118
Fordham?:	
10. Gneiss	118–125





MAP AND DIAGRAM OF BORINGS FOR PENNSYLVANIA, NEW YORK AND LONG IS



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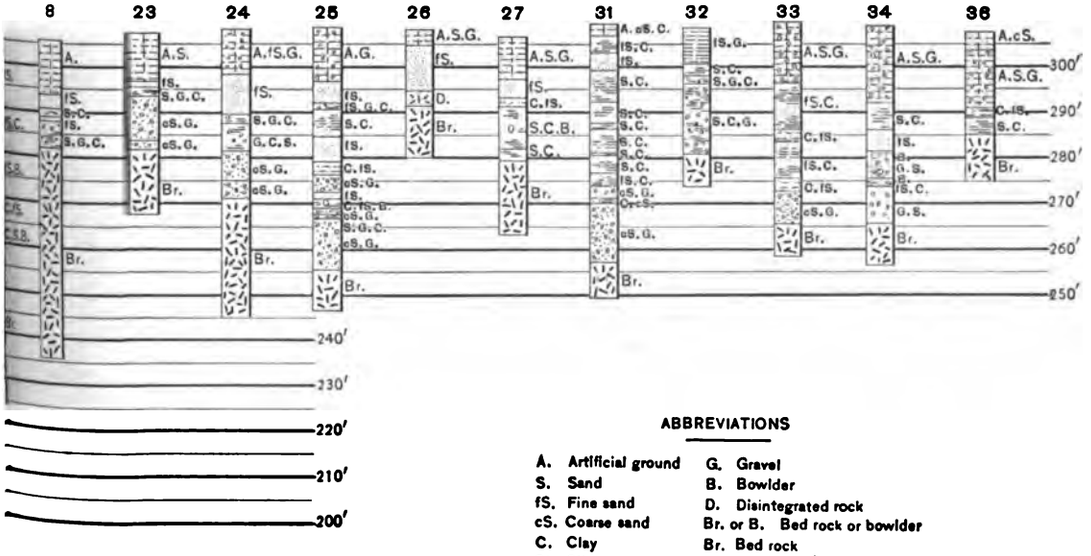


ABBREVIATIONS

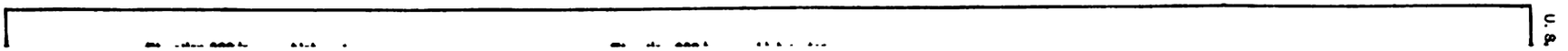
A. Artificial ground	G. Gravel
S. Sand	B. Bowlder
fS. Fine sand	D. Disintegrated rock
cS. Coarse sand	Br. or B. Bed rock or bowlder
C. Clay	Br. Bed rock
St. Silt	

Horizontal scale

0 50 100 200 300 400 500 feet

L. L. POATES ENGR'G CO., N.Y.

LAND RAILROAD TUNNEL; VERNON AVENUE TO EAST RIVER, LONG ISLAND CITY.



A well put down by the commission on additional water supply about 60 feet west of the pumping station showed the following section:

Record of commission's test well at Long Island Railroad and Grove street, Long Island City.

Wisconsin:	Feet.
3. Black humus-stained clay	5.0– 5.5
4. Grayish green sandy clay	5.5– 6.5
5. Multicolored fine silt to medium sand	9.5–10.5
6–9. Dark, multicolored, glacial sand and gravel	12.0–35
11. Fine, yellowish brown glacial sand	41 –42

100. *Record of well on Steinway avenue, between Pierce and Graham avenues, Brooklyn.*

	Feet.
1. Sand	0– 8
2. Blue clay; no bowlders	8–30
3. Quicksand with black water	30–38
4. Hardpan	38–39
5. Gravel	39–43

101. Mr. Allen sunk five wells on the east side of Fifth avenue between Pierce and Graham streets to an average depth of 32 feet; one he sunk to a depth of 60 feet and reached rock without getting a second water-bearing stratum. Water in these wells has been lowered from 18 feet below the surface to 30 feet below the surface by the pumping of the ice-factory well; and the wells have been driven 5 feet deeper, or to 37 feet. A well just across the block, on Fourth avenue, belonging to Mr. Vanderhyde, reached rock at 58 feet; water was found on the rock.

102. *Record of well at Washington and Fourth avenues, Long Island City.*

	Feet.
1. Gravel	0–10
2. Sand	10–32
3. Gravel with large bowlders	32–40
4. Blue clay	40–50
5. Red sand and gravel with some small black gravel	50–57

104. *Record of well at Pierce avenue and Crescent street, Long Island City.*

	Feet.
1. Gravel and bluish rock	0–34
2. Blue clay	34–64
3. Gravel	64–74

105. Well is pumped empty and then allowed to fill; water is used for manufacturing purposes, and not for drinking.

Sanitary analysis of water of well at Williams and Beebe avenues, Long Island City.

[By E. H. Richards.]

Appearance:	Parts per million.
Turbidity	None.
Sediment	Slight.
Color	None.
Odor:	
Cold	None.
Hot	Faintly earthy.
Total residue on evaporation	836
Ammonia:	
Free	0.006
Albuminoid	.036

	Parts per million.
Chlorine	80.000
Nitrogen as nitrites	.003
Nitrogen as nitrates	34.000
Oxygen consumed	.180

I am afraid it is a case of the border line. I do not know why the nitrates should be so high, unless there is some contamination.—*E. H. Richards, May 22, 1900.*

106. In the spring of 1903 Mr. Allen completed three wells in the kitchens of new houses on the west side of Ely street between Paynter and Beebe streets, which afforded the following section:

Records of wells on Ely avenue between Paynter and Beebe avenues, Long Island City.

	Feet.
1. Quicksand	0 –12
2. Blue clay	12 –17.5
3. Gravel	17.5–20.5
4. Sand	20.5–22.5
5. Bed rock	22.5–

The well in the house nearest Paynter street flows about 5 gallons per minute 2 feet above the ground; the others flow, but a less amount. On the corner of Beebe and Paynter streets, just northwest of the last of these houses, is an old factory with a well about 20 feet deep which reached bed rock and furnished flowing water. This well has now stopped flowing, because of the construction of the sewer along Beebe street which drains the water from it. The elevation at the corner of Ely and Paynter streets is 9 feet, city datum.

110. The water of this well is extremely brackish and can not be used in boilers; it is used for mixing clays. The elevation of the grade line, corner of Wallach and Vernon avenues, is 14.89 feet, city datum.

Record of well at 401 Vernon avenue, Long Island City.

	Feet.
1. Ash and sand filling	0– 4
2. Coarse red sand	4– 22
3. Rock	22–115

115. These wells are reported as being about one-half mile north of bridge No. 4 (Blackwells Island bridge). There are two 3-inch wells, and two 4½-inch wells.

Record of well near Blackwells Island bridge, Long Island City.

	Feet.
1. Marsh mud	0–16
2. Mud and sand	16–20
3. Sand	20–31
4. Bed rock	31–

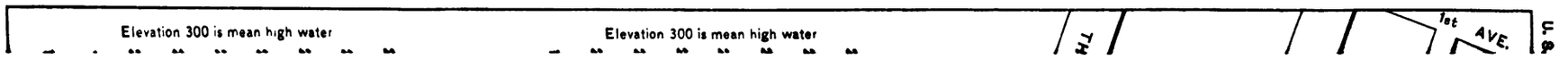
116. *Record of well at Broadway and Academy street, Long Island City.*

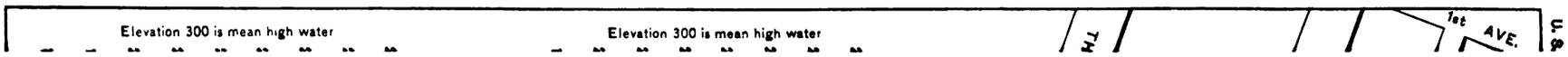
	Feet.
1. Heavy, coarse, building sand, with bowlders of various sizes	0–35
2. Very large bowlders packed closely together, many weighing a ton or more	35–40
3. Coarse gravel containing stones 4 to 6 inches in diameter	40–50
4. Very tenacious blue clay, containing no stones	50–57
5. Fine yellow sand	57–60
6. Fine white sand	60–90

The bowlders in stratum 2 so hindered the sinking of the well that it was necessary to dig a hole 10 feet square and blast them out. At 90 feet a large supply of brackish water was obtained.

117. *Record of well at Ninth and Jamaica avenues, Long Island City.*

	Feet.
1. Stratified sand and gravel	0–48
2. Fine reddish sand	48–58
3. Red sand and gravel	58–74


Elevation 300 is mean high water
Elevation 300 is mean high water
1st AVE.


Elevation 300 is mean high water
Elevation 300 is mean high water
1st AVE.

In this well the first water was encountered at 32 feet; below this was 7 feet of clayey sand and a second layer of clay and gravel.

118. *Record of well at 408 Ninth avenue, Long Island City.*

	Feet.
1. Sand with bowlders	0–50
2. Quicksand with marine shells	50–57
3. Water-bearing sand	57–
4. Very hard layer of red sand and gravel.	

119. *Record of well at Steinway and Jamaica avenues, Long Island City.*

	Feet.
1. Glacial gravel with bowlders	0–18
2. Gray sand	18–36
3. Red gravel, water-bearing	36–65

120. *Record of well at Albert street and Jamaica avenue, Long Island City.*

	Feet.
1. Unstratified glacial sand and gravel	0–4
2. Quicksand	4–39
3. Grayish clay	39–42
4. Red sand and gravel, water-bearing	42–60

121. *Record of well on Twelfth street between Broadway and Jamaica avenue, Long Island City.*

	Feet.
1. Unstratified sand and bowlders	0–30
2. Stratified red sand	30–60
3. Water-bearing gravel with more or less clay	60–65
4. Black clay	65–

Mr. Allen reports that in this vicinity the water-bearing gravel lying between the stratified sand and black clay ranges in thickness from 0 to 23 feet.

122. *Record of well at Grand street and Third avenue, Long Island City.*

	Feet.
1. Humus-stained sandy loam	0.1– 0.4
2. Reddish sandy loam	1.5– 1.7
3. Fine to medium reddish yellow silty sand	6.0– 7.0
4–6. Dark brownish gray multicolored glacial sand and gravel	11.5–23.0
7–8. Same, but with much reddish silt	24.0–31.0

123. Mr. Allen reports that this well is in an area which is about a block and a half square, in which it is quite easy to get water; outside of this local basin it is much more difficult.

125. Surface water was shut out at 225 feet, and the well tested at 352 and 608; both tests gave salty water.

126. No water encountered until 43 feet, where it was found in a crevice of the rock, and came up to within 4 feet of the surface. Water contains too much lime for boiler use. Well pumps 18 gallons a minute at suction limit.

Record of well at Steinway avenue and River road, Long Island City.

	Feet.
1. Yellow bowldery clay	0–24
2. Quicksand (very fine, clean sand—no mica)	24–37
3. Coarse, white gravel and beach sand	37–42
4. Conglomerate rock ("like the rock at Scranton, Pa., just above the hard coal")	42–45
5. Gray gneiss	45–55

128. Impotable water is reported at 14 feet; good water at 48 feet.

129. Mr. Harper states that the record of material penetrated in this well is exactly the same as in the other wells which he put down on Barren Island. (See Nos. 130 and 131.)

130. The following section has been prepared by Mr. Lewis Woolman from samples furnished by Mr. Thomas B. Harper:[a]

Record of T. F. White Company's well on Barren Island, New York.

	Feet.
Pleistocene:	
1. Interval; no specimens	0– 70
2. Brownish sands, sometimes slightly yellowish and sometimes slightly reddish in cast	70–130
3. Reddish-brown and yellowish-brown sands, same as next above, with the addition of pebbles and cobbles, etc. (Jameco)	130–220
Cretaceous:	
4. Whitish sands	220–240
5. Brown sands	240–260
6. Bluish-white sands with some lignite throughout	260–500
7. Dark, micaceous sandy clay, no lignite	500–690
8. Yellowish-white, water-bearing sand, coarse at 700 to 720 (Lloyd sand)	690–740

131. The following samples were furnished by Mr. Thomas B. Harper to the New Jersey Geological Survey:[b]

Record of Sanitary Utilization Company's well on Barren Island, New York.

	Feet.
Pleistocene:	
1. Whitish sand for some distance down from the surface; heavy gravels and cobbles at	140
3. "Reddish" (?) sand.	
4. Dark-colored conglomerate, quartz grains and pebbles size of mustard seed to that of shellbarks and walnuts at	218
5. Cobbles at some distance below	230
Cretaceous:	
6. Whitish sand.	
7. "Cemented material" of feldspar and quartz	495–500
8. Bluish soft marl (?)	500–560
9. Alterations of sands and clays, each 15 to 20 feet thick	560–660
10. Red clay at	706
11. Yellowish-white coarse sand and fine gravel, water bearing (Lloyd sand)	712–720
12. Whitish clay, prospected 4 feet, or from	720–724

132. The following section was reported by Mr. Chester D. Corwin:

Record of Sanitary Utilization Company's well on Barren Island, New York.

	Feet.
1. Medium fine gray sand	0–135
2. White beach sand	135–525
3. Hardpan, clay and stones; clay and gravel-like cement; color between gray and brown	525–530
4. White sand	530–680
5. Light-gray medium gravel; good water-bearing stratum	680–700

133. *Record of White Lead Company's well on Crook Island, New York.*

	Feet.
1. Fine gray sand	0– 95
2. Brown medium sand	95–115
3. Coarse light-gray sand	115–116
4. Brown medium sand (similar to No. 2)	116–130
5. Coarse white sand	130–134

[a] Ann. Rept. Geol. Survey New Jersey, 1897, pp. 156–157. [b] Op. cit., p. 155.

134. Mr. L. B. Ward gives the following data: "This company operates under the franchise of the Long Island Water Supply Company in the Twenty-sixth Ward, where its property is situated. It pumps 70,000 gallons of water daily from driven wells for the supply of houses built on its tract No. 1, and takes 90,600 gallons additional from the Long Island Water Supply Company for use in tract No. 2. The plant consists of a pumping station and a standpipe. It supplies 176 houses on tract No. 1 and 275 houses on tract No. 2."

135. Mr. Robert Van Buren, of the department of water supply, Borough of Brooklyn, has kindly furnished samples from the deep wells put down at New Lots in 1903. From these the following section has been compiled (see fig. 10):

Record of deep wells of department of water supply at New Lots road and Fountain avenue, East New York.

	Feet.
Recent:	
1. Peat	0– 4
Wisconsin and Tisbury?:	
2. Gray sandy clay with gravel	4– 12
3–5. Light, multicolored, fine to coarse, glacial sand	12– 70
6. Light-gray clay	70– 72
7. Fine to medium, light yellow glacial sand	72– 93
8. Reddish brown fine to coarse glacial sand	93–113
Sankaty:	
9. Light-gray gravelly clay	113–118
Jameco:	
10. Coarse, multicolored, highly erratic glacial sand and gravel	118–164

Messrs. P. H. & J. Conlan reported to the Geological Survey of New Jersey[a] in 1896 the following: "The greatest yield and the best quality of water for the Long Island Water Supply Company were found at East New York, where it is all gravel and coarse sand. The yield was about two and one-half million gallons per day from six 8-inch wells that run from 65 to 95 feet deep."

In 1898 the same firm reported:[b] "We have erected a pumping plant for the Long Island Water Supply Company in Brooklyn, N. Y. We put down five wells averaging a depth of 80 feet. Supply collectively was 2,000,000 gallons per day of 24 hours. The strata were:

Record of wells of department of water supply at New Lots road and Fountain avenue, East New York.

	Feet.
1. Loam	0– 4
2. Fine sand	4– 10
3. Gravel with water	10– 35
4. Thin vein of clay	35– 36
5. Sand and gravel	36–100
6. Clay	100–
7. Fine red sand	–140

"We went to 140 feet with one well, but got no water. It was fine red sand with much iron and no gravel, and we went no deeper. The levels of the wells are about high-tide level; a very high tide breaks up, so that they are all connected at tide level, but the water is fresh and good for use, but a little hard."

136. The following section has been prepared from the samples preserved in the office of the department of water supply in the municipal building, Brooklyn (see fig. 10):

Record of Brooklyn test well, No. 17.

	Feet.
Wisconsin:	
1. Yellow loamy sand	0– 8
2. Light, reddish-brown, fine to coarse, speckled sand	8– 70
Tisbury:	
3. Light-yellow sand and pebbles (orange sand)	70– 95

[a] Ann. Rept. Geol. Survey New Jersey for 1896, 1897, p. 186. [b] Ann. Rept. Geol. Survey New Jersey for 1898, 1899, p. 142.

	Feet.
Sankaty:	
4. Dark-gray clay with vegetable matter (swamp deposit)	95–106
Sankaty?:	
5. Light-yellow fine to medium sand	106–128
Jameco:	
6. Fine, dark, reddish-brown sand, glacial	128–140
7. Very coarse multicolored sand	140–150
8. Coarse multicolored gravel, with a very small percentage of quartz	150–170
9. Fine to coarse dark reddish-yellow sands and gravel	170–191

The elevation of the surface at this point is 10.6 feet above the Brooklyn base.

137. The following records have been prepared from the samples preserved in the office of the department of water supply, municipal building, Brooklyn (see fig. 10):

Record of Brooklyn test well, No. 4.

	Feet.
Wisconsin:	
1. Dark, humus-stained surface, sandy loam	0– 9
2. Clean reddish-brown sands and gravels of glacial origin	9– 97
Tisbury:	
3. Dirty-gray sands with a few pebbles	97–126
Sankaty:	
4. Gray pebbly clay	126–141
Jameco:	
5. Coarse multicolored gravel with a very few quartz pebbles	141–149

Mr. De Varona reports: "Water level above the blue clay is about 16 feet below the surface of the ground, and below the clay it is about 2.5 feet below the surface."[a]

Analysis of water of Brooklyn test well, No. 4.[b]

	Parts per million.
Total solids	93.000
Loss on ignition (organic and volatile matter)	29.000
Ammonia:	
Free	.014
Albuminoid	.078
Chlorine as chlorides	3.500
Sodium chloride	5.770
Nitrogen as nitrates	.422
Nitrogen as nitrites	.060
Total hardness	31.500
Permanent hardness	31.500

138. The following section has been prepared from the samples preserved by the Brooklyn department of water supply:

Record of wells at Old Spring Creek pumping station.

	Well number	1A.	2A.	3A.	4A.	5A.
Recent	1. Peat	0– 3	0– 4	0– 4	0– 2	0– 2
Wisconsin and Tisbury	2. Fine to medium yellow to reddish yellow sand with some gravel.	3–125	4–127	4–127	2–126	2–124
Sankaty	3. Gray gravelly clay	125–133	127–137	127–136	126–136	124–134
Jameco	4. Multicolored sand and gravel with relatively small percentage of quartz.	133–158	137–151	136–153	136–153	134–151

[a] Ann. Rept. Commr. City Works of Brooklyn for 1895, 1896, p. 346.

[b] Analysis by the Brooklyn health department, op. cit., pp. 140, 142.

Messrs. W. D. Andrews & Brother, who put in the original plant at this point, report under date of March 8, 1895: "At Spring Creek and Baisley trial tubes and wells were driven to a depth of 100 feet or more, from which water flowed, and would rise 2 or 3 feet above the surface if confined in a tube. By hand pumping these 2-inch wells would yield 30 to 40 gallons per minute."

Analysis of water from shallow driven well plant at Spring Creek pumping station.

[By Brooklyn health department.]

	Parts per million.
Total solids	194.429
Loss on ignition (organic and volatile matter)	40.429
Free ammonia	.005
Albuminoid ammonia	.015
Chlorine as chlorides	12.857
Sodium chloride	21.186
Nitrogen as nitrates	4.510
Nitrogen as nitrites	None.
Total hardness	110.214
Permanent hardness	809.29

139. The following analysis was furnished by Mr. I. M. De Varona:

Analysis of water from well at temporary Spring Creek pumping station.

[Analysis by Brooklyn health department.]

	Parts per million.
Total solids	223.500
Loss on ignition (organic and volatile matter)	52.000
Free ammonia	.000
Albuminoid ammonia	.017
Chlorine as chlorides	14.000
Sodium chloride	23.070
Nitrogen as nitrates	6.965
Nitrogen as nitrites	None.
Total hardness	92.500
Permanent hardness	91.000

141. Section from samples preserved by the Brooklyn water department (see fig. 10):

Record of Brooklyn test well No. 5.

	Feet.
Wisconsin:	
1. Yellow surface loam	0– 16
2. Reddish brown multicolored sands and gravel of glacial origin	16–192
Sankaty:	
3. Gray clay	192–200
4. Dark multicolored silty sand (glacial)	200–216
5. Gray silty clay	216–281
Jameco:	
6. Gray silt with multicolored pebbles (glacial)	281–284

Accompanying the samples preserved in the glass tube is a sample in an envelope, marked "Test well No. 5, below clay, received August 21, 1895." This sample consists of large dark-colored pebbles, only about one-fourth of which are quartz. Mr. I. M. De Varona adds: "When the pipe was down about 284 feet the water level was about 46 feet below the surface." Elevation of ground 61.8 feet, Brooklyn base.

Analysis of water from Brooklyn test well No. 5.

[By Brooklyn health department.]

	Parts per million.
Total solids	139.000
Loss on ignition (organic and volatile matter)	20.000
Free ammonia	None.
Albuminoid ammonia	.024
Chlorine as chlorides	8.500
Sodium chloride	14.010
Nitrogen as nitrates	.659
Nitrogen as nitrites	None.
Total hardness	63.500
Permanent hardness	63.500

142. The wells of this company are arranged in two groups about one-half mile apart, the northern one consisting of 4 wells and the southern one of 12. The pumping station is located about midway between them, in the factory of the Agate-Nickel Steel Ware Company.

Section from samples preserved in the office of the Agate-Nickel Steel Ware Company:

Record of Woodhaven Water Supply Company's well near Woodhaven.

Wisconsin and Tisbury?:	Feet.
1. Light-brown, medium, glacial sand	0–16
2–3. Coarse glacial sand and gravel, containing a large percentage of granitic and sachistose pebbles	16–31
4. Fine, light-gray, micaceous clayey sand	31–38
5–8. Brown glacial sand and gravel	38–91

The whole section is pronouncedly glacial, with the highest percentage of erratic material between 16 and 31 feet. An analysis of this water, made November 28, 1902, gave the following results:

Analysis of water from Woodhaven Water Supply Company's well near Woodhaven.

Appearance, etc., clear pale brownish yellow.
Odor (heated to 100° F.), faint earthy.

	Parts per million.
Chlorine in chlorides	11.5
Equivalent to sodium chloride	18.9
Phosphates	Trace.
Nitrogen in nitrites	None.
Nitrogen in nitrates	2.1
Free ammonia	.03
Albuminoid ammonia	.04
Hardness equivalent to carbonate of lime (before boiling)	149.7
Hardness equivalent to carbonate of lime (after boiling)	29.0
Organic and volatile (loss on ignition)	56.2
Mineral matter (nonvolatile)	146.1
Total solids (by evaporation)	193.4

143. The record of the deep well at this point has been published by Messrs. Bryson,[a] Lewis,[b] Darton,[c] and Woolman.[d] A complete set of samples presented by Mr. F. H. Luce, superintendent of the Woodhaven Water Supply Company, which are preserved in the museum of the Long Island Historical Society, show the following section:

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[a] Am. Geologist, vol. 3, pp. 214, 1889.
[b] Am. Jour. Sci., 3d ser., vol. 37, p. 233, 1889.
[c] Bull. U. S. Geol. Survey No. 138, 1896, pp. 31–32.
[d] Ann. Rept. Geol. Survey New Jersey, for 1896, 1897, pp. 158–160.

Record of well of Lalance & Grosjean Manufacturing Company near Woodhaven.

	Feet.
Pleistocene:	
1. Reddish-yellow glacial sands and gravels[a]	0–213
Cretaceous:	
2. Dark laminated clay with some quartz pebbles	213–358
3. Gray clayey sand with lignite	358–430
4. Very dark sandy clay	430–436
5. Fine white sand	436–443
6. Very dark-gray dirty sand	443–456
7. Medium white sand, with small quartz pebbles	456–460
8. Very dark clayey sand	460–475
9. Small quartz gravel	475–510
10. Fine to medium, dirty, clayey sand	510–515
11. Dark, sandy, laminated clay, with quartz pebbles	515–518
12. White or dirty gray clay	518–540
13. Dirty gray medium sand	540–556
Pre-Cretaceous:	
14. Rock	556–570

144. *Record of commission's test well near Union Place.*

	Feet.
Wisconsin and Tisbury?:	
1. Surface dark-yellow sandy loam.	
2. Reddish-yellow sandy clay	1.5
3. Dark-yellow sand and small gravel	5
4–5. Sand and coarse gravel, with much erratic material	10–15
6–7. Grayish-yellow silt and coarse sand	20–25
8. Fine to medium dark-yellow sand	30
9. Coarse, dark-gray, multicolored sand, with much erratic material	32–32.5
10. Dark-colored sand, with some silt	33–34
11–13. Dark-yellow silty sand	35–46

This whole section is apparently outwash glacial gravel.

145. *Record of commission's test well near Glendale.*

	Feet.
Wisconsin and Tisbury?:	
1. Dark humus-stained clay	0. – 0.4
2. Reddish yellow clay	1.5– 1.8
3–5. Reddish yellow silty sand	6. –18
6–16. Fine to coarse dark-gray glacial sand	24. –76

147. *Analysis of water of Montauk Brewing Company's well near Metropolitan.*

[By H. W. Walker.]

Appearance clear.
Color normal.

	Parts per million.
Odor (heated to 100° F.)	None.
Chlorine as chlorides	14.5
Sodium chloride	23.89
Nitrogen in nitrites	.00
Nitrogen in nitrates	1.186
Free ammonia	None.
Organic and volatile loss on ignition	74.5
Mineral matter not volatile	184.0
Total solids	257.0

Mr. H. W. Walker, of the Brooklyn city health department, says, August 8, 1903: "This water is of bright and sparkling appearance, and the analysis indicates a high degree of purity."

[a] In the samples the sand ends at 153 feet, but as both the Lewis and Bryson records carry it to 213 feet it has been so placed in this record.

148. *Record of commission's test well near Middle Village.*

	Feet.
Wisconsin and Tisbury?:	
1–2. Surface gravelly loam	0– 1.5
3–5. Yellowish clayey sand	5–16
6. Fine to medium, dark, multicolored sand	19–20
7. Dark yellowish brown, clayey sand, glacial	21–22
8. Dark, multicolored, fine sand to coarse glacial gravel	22–23
9–11. Dark, multicolored, clayey sand and gravel, glacial	30–37
12–20. Dark, multicolored, fine to coarse glacial sand	44–96

See Table XIII.

149. *Record of H. Bottjer's well near Middle Village.*

	Feet.
Wisconsin and Tisbury?:	
1. Surface loam	0– 3
2. Stones and clay "hard pan," with occasional streaks of water-bearing sand and gravel	3–135
?3. Coarse white sand	135–

151. A test well put down at station No. 5 gave the following section (see fig. 13):

Record of well of Citizens' Water Supply Company at Station No. 5, near Flushing Creek.

	Feet.
Wisconsin and Tisbury:	
1. Reddish-brown sand and fine gravel	0– 60
Tisbury?:	
2. Coarse reddish-brown gravel	50– 90
Sankaty?:	
3. Blue stony clay	90–190

152. *Record of commission's test well near Flushing Creek.*

	Feet.
Wisconsin:	
1–2. Surface; sandy loam	0– 2
3–4. Reddish-brown clayey sand	4–11
5–6. Multicolored glacial sand and gravel	15–22

153. Mr. L. B. Ward gives the following data: "The works of this company are located in the Second Ward of Queens Borough and were erected to supply Long Island City. They consist of three pumping stations, each containing one pumping engine, also 178 driven wells, and 7.5 miles of 12-inch and 16-inch pipe in three force mains laid to connect with the Long Island City distribution system. The pumps and pump houses are of a provisional character and the works are idle except for the formal operation of one small pump."

154. *Record of well at New Calvary Cemetery, Long Island City.*

	Feet.
1. Black mud	0–22
2. Blue clay and small blue rock	22–70
3. Bed rock	70–

155. *Record of well at New Calvary Cemetery, Long Island City.*

	Feet.
1. Blue clay and bowlder rock	0–15
2. Quicksand	15–21
3. Gravel with water	21–51

156. *Record of well at New Calvary Cemetery, Long Island City.*

	Feet.
1. Hard pan and small rocks	0–20
2. Gravel	20–56

157. *Record of commission's test well near Newtown.*

Wisconsin:	Feet.
1–3. Surface; clayey sand	1– 5.5
4–5. Yellow, clayey sand	10–13
6. Bowlder clay	15–16
7–9. Dark multicolored sand and gravel, increasing in coarseness with depth	18–26

159. *Record of commission's test well near Elmhurst.*

Wisconsin:	Feet.
1–5. Yellow loam with gravel	0 – 5
6–12. Fine to coarse, dark, multicolored sand with some gravel; "hardpan, very hard driving"	5 –41.5
13–16. Fine yellow sand and clay; "easy driving"	41.5–55
17–18. Dark multicolored sand and gravel; "hardpan"	55 –65
Bowlder or ledge at	69

See Table XII.

160. The difference in elevation between these wells is very slight. Well No. 1, if anything, is on higher ground than wells Nos. 2 and 3. There is apparently a very rapid and irregular variation in the water table.

161. See No. 153.

162. Messrs. Stotthoff Brothers report[a] the following data to the New Jersey Geological Survey (see fig. 13):

Record of Citizens' Water Supply Company's well near Woodside.

Wisconsin:	Feet.
1. Earth, clay, and bowlders	0–38
Jameco and Cretaceous?:	
2. Hard clay mixed with sand	38– 98
3. Quicksand	98–118
4. Blue clay	118–138
Fordham gneiss:	
5. Rock, "gneiss layer," etc	138–227

163. Mr. Allen reports that the bowlder in the following section was blasted and that water-bearing gravel was found immediately below it. When he penetrated the gravel 3 feet the water rose in the pipe 15 feet, or 4 feet above the bowlder.

Record of I. Isenburg's well on Albert street near Grand avenue, Long Island City.

	Feet.
1. Sand with bowlders	0–40
2. Sand and gravel	40–50
3. Large bowlder	50–58
4. Water-bearing gravel	58–61

164. Mr. S. H. Allen states that most of the wells in this vicinity are about 60 feet deep and that he encountered two water-bearing layers separated more or less by a bed of sandy clay or clayey sand. The water in the upper layer has no pressure, while that from the lower often has pressure enough to rise 5 or 10 feet. The water from the lower layer is considered better both in quantity and quality.

165. *Record of well on Thirteenth avenue near Vandeventer avenue, Long Island City.*

	Feet.
1. Unstratified sand and bowlders	0–28
2. Coarse sand and gravel	28–39
3. Hard sand with bowlders	39–46
4. Clear sand with water	46–56
5. Large bowlders	56–
6. Water-bearing sand	
7. Water-bearing gravel	–72

[a] Ann. Rept. Geol. Survey New Jersey for 1899, 1900, p. 80.

166. *Record of commission's well on Bowery Bay road near Flushing avenue, Long Island City.*

Wisconsin:	Feet.
1–2. Yellow sandy loam	0– 6
4. Very fine dark-gray sand and clay	10–11
5. Very fine yellow sand and clay	15–16
6–11. Fine to coarse, multicolored glacial sand and gravel	16–40
12. Rock or bowlder	40–

See Table XII.

167. *Record of well at Albert street and Ditmars avenue, Long Island City.*

Wisconsin:	Feet.
1–2. Yellow surface loam	0– 3
3–5. Fine, yellow, silty sand and gravel	5–16
6–10. Clean, coarse, multicolored glacial sand and gravel	20–39
11. Rock or bowlder	39–40

168. Mr. S. H. Allen completed a well at this place 79 feet 9 inches deep, which yielded 210 gallons per minute. This well ended on what appeared to be bed rock. Later the well was deepened, and after drilling 32 feet the rock was penetrated and quicksand found. It was found impossible to obtain water from this quicksand and a new well was drilled to the original depth.

Record of Astoria Silk Works' well on Steinway avenue, near Ditmars avenue, Long Island City.

	Feet.
1. Hardpan	0–51
2. Bowlder	51–53
3. Water-bearing sand and gravel	53–80
4. Rock	80–112
5. Quicksand	112–

169. *Record of well on Potter avenue near Park Place, Long Island City.*

	Feet.
1. Solid stone and hard pressed gravel	0–40
2. Blue clay	40–48
3. Quicksand, black	48–56
4. Micaceous sand with water; took quite a time to clear	56–63

170. *Record of well at Merchant street and Ditmars avenue, Long Island City.*

	Feet.
1. Sand and bowlders	0–32
2. White sand and gravel	32–40
3. White sand packed very hard	40–48

171. *Record of well near Merchant street and Ditmars avenue, Long Island City.*

	Feet.
1. Sand and gravel	0–25
2. Fine sand	25–30
3. Sand and bowlders	30–37
4. Solid rock with water in crevice of rock	37–45

172. *Record of well at Crescent street and Ditmars avenue, Long Island City.*

	Feet.
1. Sand and gravel	0–42
2. Bed rock or bowlder	42–

173. *Record of commission's test well at Lawrence street and Wolcott avenue, Long Island City.*

	Feet.
Pleistocene:	
1–2. Surface loam	0– 2.5
3. Fine yellow sand	
4. Small gravel of a dark mud color	
5. Yellow to dark-brown rock flour formed from drilling in bowlder	12–12.5
6. Multicolored glacial sand and gravel	14–31

See Table XII.

176. Mr. L. C. L. Smith, consulting engineer, reports that there are 17 wells at this station which pass through the following material:

Record of wells of Bowery Bay Building and Improvement Association, at North Beach.

	Feet.
Wisconsin and Tisbury?	
1. Sand	0–45
Sankaty?	
2. Clay	45–60
Jameco:	
3. Water-bearing strata	65–70

Sweeney & Gray, drillers, report the following section:

Record of wells of Bowery Bay Building and Improvement Association at North Beach.

	Feet.
Wisconsin to Tisbury?	
1. Sandy top soil varying in color from white to yellow	0–20
2. Compact mixture of sand and gravel	20–32
Sankaty?	
3. Blue and gray clay in alternating layers	32–36
Jameco?	
4. Very coarse sand and gravel in alternate layers	36–82

177. This is the locality from which the wells described by Darton as "Bowery Bay: 110 feet deep; 6 inches in diameter; one flowed 50 gallons," were reported. It seems that several parties attempted wells at this point, but that no results were obtained until after this information had been given the Survey, when three 6-inch wells were put down in a near-by hollow to a depth of 40 or 50 feet, the present water supply being derived from these. Mr. I. H. Ford states that the first well was sunk to a depth of 400 or 500 feet, but no further data has been obtained regarding it.

178. See No. 153.

179. *Record of commission's well at Trains Meadow and Highway roads, Long Island City.*

	Feet.
Recent:	
1–2. Yellow surface loam	0– 2
3. Dark clay with decayed glacial pebbles and peat	5– 6
Wisconsin:	
4. Very fine, grayish or reddish brown, clayey sand, glacial	10–28.5

180. *Record of commission's well on Trains Meadow road near Jackson avenue, Long Island City.*

	Feet.
Wisconsin:	
1–2. Surface loam	0– 3
3. Yellow clay with considerable MnO_2	5– 5.5
4–5. Fine, dark-colored, micaceous clayey sand	10–13.5
6. Yellow clayey sand	15–16
7. Medium, coarse, multicolored gravel	17–18
8. Yellow clayey sand	19–20
9–10. Fine to coarse multicolored sand and gravel	22–26
11. Dark reddish speckled sand suggesting disintegrated Triassic sandstone	30–31

See Table XII.

181. *Record of commission's test well at Junction avenue and Strongs lane, Long Island City.*

Wisconsin:	Feet.
1–2. Missing.	
3. Light-yellow clayey loam with pebbles, "bowlder clay"	7 – 8
4–7. Reddish yellow, fine to medium, silty sand	14.0–30.5
8–11. Dark multicolored glacial sand and gravel	36.5–53.0

182. A. D. Schlissinger, president of the India Rubber Comb Company, reports as follows:

Record of India Rubber Comb Company's well near College Point.

	Feet.
1. Sand and gravel	0–35
2. Black muck and water smelling of clams	35–

184. C. D. Corwin reports the following section from this well:

Record of well of American Hard Rubber Company, near College Point.

	Feet.
1. Filled ground	0– 8
2. Yellowish clay and sand	8–25
3. Hard pan, yellow clay, and stones, impervious to water; like macadamized roads	25–60
4. Water-bearing gravel and light-brown coarse sand	60–70
5. Yellow clay and stones	70–85

186. A sketch in the museum of the Long Island Historical Society by Mr. C. M. Jacobs, consulting engineer, gives the following section of the test well at this point:

Record of railroad test boring on Tallman Island, New York.

Pleistocene:	Feet.
1. Sand and trap bowlders; old sea beach	0 – 7.3
2. Yellow quartz sand	7.3– 30
3. Quartz gravel and bowlders	30 – 31.5
4. Yellow quartz sand, medium fine	31.5– 50
5. Trap bowlders, quartz sand, and gravel; regular glacial drift	50 – 57
6. Sand	57 – 63
7. Quartz gravel	63 – 66
8. Gravel and sand	66 – 73.3
9. Quartz gravel	73.3– 76.3
Cretaceous:	
10. Soft clay	76.3– 79.3
11. Lignite intermixed with clay bands	79.3– 91.7
12. Streaked red and white clay; hard, bored out as a solid core	91.7–110.4
Fordham:	
13. Soft, white micaceous "sandstone," the upper part of which was so soft as to wash to powder under diamond drill; below it gradually became less micaceous and harder, the lower part coming out as a solid core	110.4–159

The core mentioned in No. 13 is regarded by Mr. Eckel as quartzitic Fordham.

187. Lawrence Verdon says: "Stopped at 112, as I could get the well no farther."

Record of James Caffery's well near Far Rockaway.

Tisbury:	Feet.
1. Water-bearing strata, almost clear gravel	0– 42
Sankaty:	
2. Clay	42– 66
Jameco:	
3. Black sand with water which looked and tasted good	66– 88
4. No record	88–112

188. This well was put down by Mr. Gilbert Baldwin under the direction of Mr. Jesse Conklin. Mr. Conklin, under date of April 25, 1895, gives the following: "At Far Rockaway, about one-fourth mile from the ocean I drove a well 210 feet. I found water at 15 feet from the surface and got a good supply. I drove 180 feet through beach sand and gravel. At 195 feet struck petrified wood. Last 15 feet was clear white gravel, with a very good supply of water of about 40 gallons." From Mr. Baldwin it is learned that this water was so salty that the well was abandoned. The record, according to Mr. Baldwin, is as follows:

Record of B. L. Carroll's well near Far Rockaway.

	Feet.
Tisbury:	
1. Fine beach sand	0– 25
2. Coarse sand and gravel	25– 45
Sankaty:	
3. Blue clay; no stones	45– 65
Jameco and Cretaceous?:	
4. Fine gravel and sand with brackish water (this layer furnished but a small quantity of water)	65–180
5. Coarse gravel with a vigorous supply of salty water	180–190

The second well was drilled at a distance of about 400 feet, and Mr. Carroll reports the following section:

Record of B. L. Carroll's well near Far Rockaway.

	Feet.
Tisbury:	
1. Beach sand	0–20
Sankaty:	
2. Blue clay	20–60
Sankaty and Jameco:	
3. Quicksand	60–90
Jameco:	
4. Gravel	90–

The water from this layer was of sufficiently good quality for ordinary use. Analysis showed a large amount of chlorine, but this was not sufficient to be perceptible to the taste.

189. *Record of James Caffery's well near Far Rockaway.*

	Feet.
1. Ordinary soil, sandy loam	0– 2
2. Fine sand with no gravel except in streaks	2–30

Mr. Walsh reports that the material was so fine that he used a Cook strainer to prevent the sand from entering the tube and clogging the well. He adds that in general the water on Rockaway Ridge occurs from 12 to 18 feet below the surface, and that the water near the center of the ridge is better in quality than that near the margin. At the edge of the meadows there is a fine nonwater-bearing sand.

190. The following analysis is reported by the Long Island Railroad Company:

Analysis of water from railroad well at Far Rockaway.

	Parts per million.
SiO_2 and F_2O_3, etc.	4.8
$CaCo_3$ and $MgCO_3$	Traces.
$CaSO_4$	88.1
$CaCl_2$	15.7
$MgCl_2$	68.2
NaCl	31.1
Total solids	207.9

A corrosive water at 200 pounds pressure.

191. This was the site of the first plant of the Queens County Water Company. Mr. C. A. Lockwood, who put in the wells, reports that there were twenty 5-inch wells, 50 feet deep. These were entirely in light-brown sand and gravel. As these wells did not yield a sufficient supply two deep wells were sunk to a depth of 200 feet, but in both brackish water was encountered and they were abandoned.

The section reported is as follows:

Record of well of Queens County Water Company near Far Rockaway.

	Feet.
Tisbury:	
1. Light-brown sand and gravel similar to the rest of the Rockaway Ridge material	0– 60
Sankaty:	
2. Blue clay	60–100
Jameco and Cretaceous?:	
3. Beach sand	100–200

The above record is for the well nearest the bay north of Far Rockaway; the one farther south near the railroad station contained clay from 60 to 78 feet.

193. *Record of T. R. Chapman's well on Hooks Creek.*

	Feet.
Wisconsin and Tisbury:	
1. Sand	0–
2. Quicksand	
3. Alternate layers of sand and clay; brackish water	–140
Sankaty:	
4. Dark-colored clay	140–200
5. Very hard clay; required 120 blows from 1-ton hammer to drill 1 inch	200–202
Jameco:	
6. Gravel with artesian water	202–203

Water at first flowed a good stream several feet above the surface, but the yield is now much less.

195. The following record has been prepared from samples preserved by the department of water supply in the municipal building, Brooklyn (see fig. 10):

Record of Brooklyn test well No. 16 at Shetuckei pumping station.

	Feet.
Wisconsin:	
1. Fine, dark-brown, loamy sand	0–20
2. Fine to coarse, light, yellowish white, speckled sand	20–89
Tisbury:	
3. Fine gray sand	90–105
4. Fine to coarse reddish-brown sand	105–135
Sankaty:	
5. Gray clay	135–146
Jameco:	
6. Dark multicolored sand and gravel with some clay (glacial)	146–154

Elevation of ground, 12.7 feet Brooklyn base; water was found below the blue clay, and water level was originally 9 feet from the surface. The elevation of the water in this test well ranged from 11 to 17 feet below the surface in 1901.

196. The following records have been compiled from the manuscript reports of Mr. Peter C. Jacobson which were kindly placed at our disposal by chief engineer I. M. De Varona (see fig. 10):

Records of wells at Springfield pumping station.

Well No.	Section. Sand.	Blue clay with wood and sand.	Water-bearing sand and gravel; some wood and clay.	Total depth.	Flow per minute.	Yield for 24 hours.	Remarks.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*	*Gallons.*	
[a] 15	0–74	74–182	182–207	207	.....	[b] 700,000	
3	0–50	50–117	117–177	177	15	.....	Sand with water, no gravel, 117 to 134 feet.
2	0–50	50–124	124–178	178	.....	.....	Began to flow at 134 feet.
4	.....	.....	.....	177	15	.....	Flow increased to 25 gallons on washing out.
6	.....	.....	160–177	177	20	.....	Water-bearing sand and gravel at 160 feet.
7	.....	.....	160–177	177	15	[c] 1,000,000	Do.
8	.....	.....	139–179	179	[d] 15	.....	Do.
9	.....	76–135	.....	.....	.....	.....	Flows at 135 feet.
10	.....	.....	132–156	156	.....	.....	
11	.....	.....	.....	157	.....	.....	
12	.....	.....	.....	158	.....	.....	Fine sand and gravel worked down for bottom.

[a] This is from a report on this well made in July, 1897.
[b] August 24, 1897.
[c] November 17, 1897.
[d] October 26, 1897.

In the report for June 7, 1897, the following record is given, apparently referring to well No. 15:

Record of well 15 at Springfield pumping station.

	Feet.
Wisconsin:	
1. Sharp water-bearing sand	0–25
Tisbury:	
2. Fine hard packed sand with very little water	25–78
Sankaty:	
3. Blue clay with sand and gravel	78–123
Jameco:	
4. Small gravel and sand with a large percentage of carbonized wood; water bearing; water level 6 inches above surface; will yield with hand pump 75 gallons per minute; pumping with hand pump lowers it 6 feet; when pumping is stopped the level of 6 feet is recovered in ½ minute	123–129
5. Sand of various fineness containing carbonized wood and clay	129–158
6. Gravel, sand, and a little clay mixed; water bearing	158–178

On June 14 it was stated that the flow of well 15 had increased to 9 gallons per minute and that its pumping capacity was almost a million gallons a day.

As no samples from these wells were preserved and as the data are very meager and somewhat confusing, it is not possible to arrive at a very satisfactory conclusion regarding the exact structure at this point. From the location of the wells and from the data furnished by adjoining wells it is felt that the water-bearing sands and gravels are, in part at least, Jameco, and the blue clay, Sankaty. The locality is very near the eastern edge of the old Sound River Valley, and the irregularity of the lower part of this section is doubtless due to

the unevenness of the old land surface and the redeposition of the pre-Pleistocene materials. The statement of the inspector that the water-bearing stratum grows finer and the gravel less toward the west seems to indicate a rise in the old surface in that direction, as indicated in fig. 10. Toward the east it is known from the samples of well No. 197 that the pre-Pleistocene beds are very near the surface. All the data at hand point to the conclusion that the development at this place is in a small valley in the older beds.

Analysis of Springfield Pond pump well at Springfield.

[Surface water; analysis by Brooklyn health department.]

	Parts per million.
Total solids	86.00
Loss on ignition (organic and volatile matter)	29.10
Free ammonia	.06
Albuminoid ammonia	.12
Chlorine as chlorides	10.58
Chlorine equivalent to sodium chloride	17.48
Nitrogen as nitrates	2.13
Nitrogen as nitrites	None.
Hardness equivalent to carbonate of lime (before boiling)	28.80
Hardness equivalent to carbonate of lime (after boiling)	26.90

197. The following record has been prepared from the samples preserved by the Brooklyn waterworks in the municipal building, Brooklyn (see fig. 10):

Record of well near Springfield pumping station.

	Feet.
Wisconsin:	
1. Fine to medium, light, reddish-yellow sands	0 – 33
2. Same, but a little lighter	33 – 39
3. Light, brownish-yellow, fine to medium sands	39 – 54
Tisbury:	
4. Bright-yellow silt (looks like surface loam)	54 – 56
5. Fine olive-yellow sand	56 – 59
6. Bright-orange fine to coarse sand	59 – 77
7. Light-yellow sand	77 –106.5
Jameco?:	
8. Fine steel-gray sand with quartz, jasper, and ferruginous sandstone pebbles	106.5–109.5
Cretaceous:	
9. Very dark-blue clay (different from clay above the glacial gravels)	109.5–130
10. Light-gray sands with lignite at 136 and 140	130 –234
11. Lignite	234 –236
12. White clay	236 –251
13. Dark-blue clay	251 –258
14. Fine gray sand	258 –271

In addition to the samples preserved in the glass tube, there are a number of samples in cans which may be described as follows: 107–110, several large quartz, jasper, and ferruginous sandstone pebbles; 110–125, lignite and gray clay; 125, lignite and pyrite; "130, specimen found in white sand October 25, 1895"—large pieces of lignitized wood, evidently part of a tree. Elevation of surface is 10.3 feet, Brooklyn base.

199. Section prepared from samples preserved by the Brooklyn water department, in the municipal building, Brooklyn:

Record of test well No. 18, near Oconee pumping station.

	Feet.
Wisconsin:	
1. Dark reddish-brown loam	0– 8
Wisconsin and Tisbury:	
2. Fine to coarse, light, reddish-yellow sand	9– 56
Tisbury:	
3. Fine, light, grayish-yellow sand	56– 89
4. Dark, medium, reddish-brown sand	89–115

	Feet.
Sankaty:	
5. Fine gray clay	115–185
Jameco:	
6. Dark, multicolored, very coarse sand (glacial)	185–192

Elevation of surface, 10.3 feet; average height of water in December, 1901, 17 feet from the surface; in November of the same year, 16.2.

200. Section prepared from samples preserved by the Brooklyn water department, in the municipal building, Brooklyn (see fig. 10):

Record of test well at Baisley's pumping station.

	Feet.
Wisconsin:	
1. Yellowish sand and gravel	0 – 21.5
2. Fine yellow sand	21.5– 34
3. Coarser yellowish sand	34 – 39
Tisbury:	
4. Fine yellowish sand	39 – 58
5. Gray sand and gravel	58 – 77.5
6. Gray sand	77.5– 97.5
7. Yellowish sand and gravel	97.5–103
8. Yellowish sand, gravel, and clay	103 –106
Sankaty:	
9. Blue clay	106 –139.5
10. Blue clay and quicksand	139.5–156
Jameco:	
11. Black sand and gravel	156 –166
12. Black sand	166 –174
13. Finer black sand	174 –200

Elevation of surface, 6.7 feet; see report of Andrews & Bro., under No. 138.

Analysis of water from test well at Baisley's pumping station.

[By Brooklyn health department.]

	Parts per million.
Total solids	167.50
Loss on ignition (organic and volatile matter)	58.12
Free ammonia	.06
Albuminoid ammonia	.02
Chlorine as chlorides	37.98
Chlorine equivalent to sodium chloride	62.61
Nitrogen as nitrates	2.39
Nitrogen as nitrites	.05
Hardness equivalent to carbonate of lime (before boiling)	68.68
Hardness equivalent to carbonate of lime (after boiling)	61.37

201. The following summary of the material penetrated at the Jameco pumping station has been prepared from the samples preserved by the Brooklyn waterworks (see fig. 10):

Records of wells at Jameco pumping station.

	Well number	Cramer. No. 1.	Cramer. No. 2.	2A	3A.	4A.	1B.	2B.	3B.	4B.	5B.	6B.	8B.	9B.	10B
Recent.	1. Peat and silt.		0 to 5	0 to 5	0 to 5	0 to 5			0 to 6		0 to 5	0 to 2.5		0 to 4.5	0 to 6
	2. Yellow loam.						0 to 5	0		0			0 to 2		
Wisconsin.	3. Fine to coarse reddish-yellow sand and gravel, containing considerable material of glacial origin and perhaps representing Wisconsin outwash.	0 to 30	5 to 32	5 to 20	5 to 18	5 to 22	5 to 31	to 33	6 to 31	to 25	5 to 34	2.5 to 38?	2 to 37	4.5 to	6 to 39
Tisbury.	4. Very light-yellow to gray sands, generally very fine, but occasionally containing a few pebbles. Contains very little material which is clearly of glacial origin.	30 to 84	32 to 84	20 to 83	18 to 81	22 to 79	31 to 80	33 to 83.5	31 to 86.5	25 to 83	34 to 87.5	38? to 80	37 to 78	to 80	39 to 84
Sankaty.	5. Dark-gray ("blue") clay.	84 to 105	84 to 106	83	81	79	80	83.5	86.5	83	87.5	80	78	80	84
	6. Fine grayish-yellow silty sand with pebbles.	105 to 113	106 to 114	(a) to	(a) to	(a) to	(a) to	(a) to	(a) to	(a) to	(a) to	(a) to	(a) to	(a) to	(a) to
	7. Dark-gray ("blue") clay.	113 to 141	114 to 137	141	138	137	141	141.5	141	143	140	144	143	143	135
Jameco.	8. Dark-brown, highly erratic, multicolored sand and gravel.	141 to 160	137 to 161	141 to 154	138 to 150	137 to 151	141 to 154	141.5 to 153.5	141 to 155	143 to 157	140 to 153	144 to 153	143 to 157	143 to 161	135 to 145

[a] Stratum 6 absent.

The 183 shallow-driven wells which originally constituted this station were supplemented by 7 deep wells. Data regarding these is presented by Chief Engineer I. M. De Varona in the following table:

Records of deep wells at Jameco pumping station.

No. of well.	Size of well.	Size of suction.	When completed.	Depth driven.		Rate of normal flow per 24 hours.	Yield per 24 hours, when pumped.
	Inches.	*Inches.*		*Ft.*	*in.*	*Gallons.*	*Gallons.*
186	4	2	1891	165	0	30,240	172,800
185	4	2½	1892	163	0	34,560	158,400
100	4	2½	1892	150	4	129,600	403,200
.....	4	2½	1893	157	4½	34,560	504,000
.....	6	2½	1893	151	4½	684,000	720,000
.....	6	4½	1893	154	9	144,000	432,000
.....	6	4½	1893	150	10	201,600	864,000

In 1894 wells No. 100 and 186 were pulled up, cleaned, and redriven to depths of 157 feet 8 inches and 160 feet 7 inches, respectively. After being cleaned the normal flow of well No. 100 was 4,320 gallons per day, and with a pump it yielded 20,160 gallons; well No. 186 flowed 5,760 gallons per day, which was increased to 60,480 gallons by pumping. No. 185 was tested without cleaning, and flowed 20,160 gallons, and with a pump yielded 90,000 gallons per day of twenty-four hours.

The results from these wells were so satisfactory that arrangements were made with Messrs. Andrews & Bro. to construct additional wells. Four 8-inch wells completed late in 1894 gave the following results:

Records of Andrews deep wells at Jameco pumping station.

No. of well.	Thickness of sand stratum.		Thickness of clay stratum.		Length of pipe in water-bearing stratum.		Normal yield per 24 hours.
	Ft.	*in.*	*Ft.*	*in.*	*Ft.*	*in.*	*Gallons.*
1A	82	0	55	6	10	4	201,000
2A	83	0	59	4	11	5½	144,000
3A	81	6	57	9½	11	4	159,000
4A	78	10	58	8	12	7½	222,000

In January, 1895, a test was made of these wells extending over a period of twelve days, during which time the wells were run under various combinations, from singly to all four together; the gaging showed an average daily delivery of over 1,000,000 gallons when one well was being pumped, and 3,500,000 gallons with the four wells connected. During the period of observations the elevation of the underground water at the 2-inch test wells, Nos. 8 and 9, at Jameco (each of which was about 140 feet deep), and the deep test well at Baisley's station (No. 200), about one-half mile distant, was noted. The lowering of the water at the station was approximately 5 feet when 1,000,000 gallons were being pumped, and 10 feet when the delivery was 3,500,000 gallons. The greatest lowering shown at Baisley's deep test well was slightly over 4 feet. The effect of the rise and the fall of the tide on the level of the ground water could not be taken into account at the time in determining the lowering of the water.

Early in 1895 Mr. C. P. Cramer, of Paterson, N. J., completed a 10-inch well 160 feet deep, which flowed 150,000 gallons in twenty-four hours. A test of the four 8-inch Andrews wells (Nos. 1A, 2A, 3A, and 4A) and the 10-inch Cramer well (No. 5A), was made from December 9 to 28, 1895, the wells being run singly and in groups of from 2 to 5. Elevations of the deep underground water level were taken at the Jameco test wells Nos. 8 and 9, at the 5-inch test wells Nos. 1, 2, 4, 5, 7, and 11, and at Baisley's deep test well. The average daily yield per well was approximately 1,000,000 gallons, with nearly a pro rata increase for each well connected, making the total yield about 5,000,000 gallons. During the test, lasting twenty days, the total amount pumped was 61,239,555 gallons, and when pumping the maximum of 5,000,000 gallons daily the greatest lowering of water at Jameco was slightly over 14 feet.

The greatest lowering of water in the deep test wells during the above test is given as follows:

Depth to which water level in neighboring deep test wells was lowered by pumping at Jameco station, December 9–28, 1895.

	Feet.
Jameco test well No. 8	15.23
Jameco test well No. 9	13.44
Baisley's deep test well (200)	8.86
Test well No. 1 (202)	9.99
Test well No. 2 (203)	8.69
Test well No. 4 (137)	.31
Test well No. 5 (141)	.91
Test well No. 7 (206)	1.53
Test well No. 11 (212)	7.25

The locations of these wells are shown on Pl. XXIV.

Analyses of waters from wells at Jameco pumping station.

[By the Brooklyn health department.[a] Parts per million.]

	Old driven wells (shallow).	Old driven wells (deep).	No. 2A (Andrews).	No. 4A (Andrews).	No. 5A (Cramer).
Number of analyses	2	1	4	3	1
Total solids	174.50	125.00	119.25	123.66	138.00
Loss on ignition (organic and volatile matter)	44.50	20.00	15.50	19.33	35.00
Mineral matter	130.00	105.00	103.75	104.33	103.00
Free ammonia	.48	.78	.77	.61	1.04
Albuminoid ammonia	.14	.15	.07	.7	.00
Chlorine as chlorides	32.50	4.50	9.37	6.66	6.00
Sodium chloride	53.56	7.42	15.44	10.98	9.89
Nitrogen as nitrates	.42	.71	.31	.34	.00
Nitrogen as nitrites	None.	None.	None.	None.	None.
Total hardness	50.75	92.00	70.00	72.83	60.50
Permanent hardness	50.75	87.00	40.25	69.16	60.50

[a] Ann. Rept. Comm. City Works, Brooklyn, 1895, pp. 139, 141.

A letter from W. D. Andrews & Bro., dated May 8, 1895, gives the following: "In 1890 at Jameco Park we, on our own account, sunk test wells 4, 5, and 6 inches in diameter. From veins of water varying in depth from 30 to 160 feet the water rose 10 feet above the surface. The natural flow from one 4-inch open-ended pipe was 90 gallons per minute. Another 6-inch tube delivered at the ground level 500 gallons per minute and rose inside of the tube 11 feet above the surface. During Major Boody's term we made several 6-inch wells at Jameco station having an average depth of 150 feet and a natural flow at the surface of 120 to 180 gallons per minute."

202. The following section has been prepared from samples preserved by the department of water supply, municipal building, Brooklyn:

Record of Brooklyn test well No. 1, Brooklyn aqueduct and Cornell Creek.

	Feet.
Wisconsin:	
1. Light yellowish sands and gravel, glacial	0– 54
Tisbury:	
2. Fine, yellowish-gray, "pepper and salt" sand	54– 62
3. Fine yellowish-white sand	62– 75
4. Grayish white silty sand and gravel (very few glacial pebbles)	75– 89
Sankaty:	
5. Gray clay	89–142
Jameco:	
6. Dark multicolored sands and gravel	142–156

"When the well casing was worked down to the surface of the ground the flow was 30 gallons per minute. The normal level of the water in the strata below the clay bed was 0.75 foot above the surface of the ground."[a]

[a] Ann. Rept. Dept. City Works, Brooklyn, for 1895, 1896, p. 343.

Analysis of water from Brooklyn test well No. 1, Brooklyn aqueduct and Cornell Creek.

[By Brooklyn health department.]

	Parts per million.
Total solids	124.00
Loss on ignition	14.00
Free ammonia	2.05
Albuminoid ammonia	.00
Chlorine as chlorides	5.50
Sodium chloride	9.06
Nitrogen as nitrates	.37
Nitrogen as nitrites	None.
Total hardness	75.00
Permanent hardness	47.00

203. The following section has been prepared from the samples preserved by the Brooklyn water department (see fig. 10):

Record of Brooklyn test well No. 2, Brooklyn aqueduct and Rockaway road.

	Feet.
Wisconsin:	
1. Fine to very coarse reddish silty sand	0– 19
Tisbury:	
2. Fine light, yellowish gray, "pepper and salt" sand	19– 43
3. Fine, darker, yellowish gray sand; some pebbles near bottom of layer	43– 72
4. Fine grayish sand	72– 83
Sankaty:	
5. Dark-gray silty clay	83–140
6. Very fine, dark-gray, sandy silt	140–154
Jameco:	
7. Dark multicolored sands and gravels; only a small percentage of quartz (pronouncedly glacial)	154–258

"At a depth of 169 feet the water rose in the well to within 18 inches of the surface. When the pipe was down to 239 feet, the top of the pipe being 2.25 feet below the surface of ground, the flow was 5 gallons per minute." Elevation 7.4 feet, Brooklyn base.

Analysis of water from Brooklyn test well No. 2, Brooklyn aqueduct and Rockaway road.

[By Brooklyn health department.]

	Parts per million.
Total solids	48.00
Loss on ignition	15.00
Free ammonia	.51
Albuminoid ammonia	.10
Chlorine as chlorides	7.00
Sodium chloride	11.54
Nitrogen as nitrates	.76
Nitrogen as nitrites	.05
Total hardness	16.00
Permanent hardness	16.00

204. The following section has been prepared from the samples preserved by the Brooklyn water department (see fig. 10):

Record of Brooklyn test well No. 3, Brooklyn aqueduct and New York avenue.

	Feet.
Wisconsin:	
1. Reddish yellow silty sand and gravel	0– 9
Wisconsin and Tisbury:	
2. Fine to coarse reddish yellow sand with pebbles in lower portion (glacial)	9– 45
Tisbury:	
3. Fine light-yellow sand	45– 86
Sankaty:	
4. Dark-gray, silty, lead-colored clay	86–139
5. Very fine, dark-gray, silty sand	139–158
6. Medium, dark-gray, silty sand	158–160
7. Gray clay	160–201
Jameco:	
8. Dark, multicolored, silty, fine to coarse sand (glacial)	201–277

Elevation 9.8 feet, Brooklyn base.

In addition to the samples preserved in the glass tube a number were found in a can marked "Third, 5-inch test well;" they are as follows: "69 feet clay," light-gray silty clay; "72 feet wood," small pieces of peat, evidently a swamp deposit; "140 to 158 feet wood," fragments of lignitized driftwood; "161 to 202 feet wood," lignitized pieces of driftwood. "No water was found in the strata below the clay bed."

205. The following section has been prepared from the samples preserved by the Brooklyn water department (see fig. 10):

Record of Brooklyn test well No. 8, Brooklyn aqueduct and Farmers avenue.

	Feet.
Wisconsin:	
1. Reddish yellow fine to coarse sand	0– 27
Tisbury:	
2. Light, brownish yellow, fine to coarse sand	27– 59
3. Fine speckled gray sand	59– 72
Sankaty:	
4. Gray clay	72–212
Jameco:	
5. Dark, multicolored, fine to medium, dirty glacial sand (same as 8 in well 204)	212–260
Cretaceous:	
6. White micaceous sand	260–293

Elevation 10 feet, Brooklyn base.

The following samples were preserved in can marked "Eighth, 5-inch test well:" "59.7 to 72.3 feet, specimens found in gray sand October 7, 1895"—water rolled twigs (only slightly lignitized), water rolled pieces of lignite, and large flakes of muscovite; "258 to 275 feet, specimens found in sharp white sand October 14, 1895," fragments of lignitized wood; "258 to 275 feet," several small pieces of yellow amber, and a piece as large as a pigeon's egg of yellow gum. No water was found in the strata below the clay bed.

206. The following section has been prepared from the samples preserved by the Brooklyn water department (see fig. 10):

Record of Brooklyn test well No. 7, Brooklyn aqueduct, northwest of Springfield pumping station.

	Feet.
Wisconsin:	
1. Yellow surface loam	0– 3
2. Light, multicolored, clean, fine to coarse sand	3– 20
Tisbury:	
3. Clean, reddish yellow, fine to coarse sand	20– 32
4. Dirty yellowish-white, medium, "pepper and salt" sand	32– 43
5. Fine to coarse, dark, yellowish gray sand	43– 65

	Feet.
Sankaty:	
6. Gray clay ("blue clay")	65– 70
7. Same as 5	70– 78
8. Gray clay	78–170
Jameco:	
9. Reddish yellow multicolored sand and pebbles (glacial)	170–183
Cretaceous:	
10. Fine to coarse white sand with a few slightly darker quartz pebbles below	183–420

The following samples are preserved in cans:

"90 to 95 feet," pieces of gray clay with vegetable matter, apparently marsh or swamp deposit.

"88 feet, drilled through something hard for about a foot, presumably a log, as these fragments of wood were washed up." "These fragments of wood" prove to be pieces of peat made up of parts of many small plants closely compacted.

"230 feet," large pebbles of rose quartz, much disintegrated felspathic rock, black chert, banded limestone, ferruginous sandstone, conglomerate, iron pyrite, and lignite.

"Contained in gravel washed up from a depth of 171 feet"—fragments of soft red Newark sandstone.

"Pieces of wood washed up from a depth of 196 feet September 6, 1895"—lignitized wood, evidently parts of a log.

As the material in the tube from 183 to 420 is clearly not glacial, the sample from 230 shows some disagreement. According to the tube samples the glacial material ended at 182 feet, while according to the samples in the cans it extends to at least 230 feet.

Elevation of surface, 10 feet Brooklyn base. "No water was found in the strata below the clay bed."

207. *Record of commission's test well near New York and Locust avenues, south of Jamaica.*

	Feet.
Wisconsin:	
1–2. Surface loam	0.5– 1.5
3–9. Outwash gravel	5.0– 29.5

See Table XII.

208. *Record of commission's test well on Rockaway road.*

	Feet.
Wisconsin:	
1– 2. Yellow surface loam	0.5– 1
3–10. Outwash gravel with quite a considerable percentage of erratic material	5– 31

See Table XII.

209. *Record of commission's test well, 2 miles south of Dunton.*

	Feet.
Wisconsin:	
1– 2. Coarse sandy loam	0– 2
3– 9. Yellowish-red glacial sand and gravel	2– 35
10–12. Dark, yellowish-gray, fine sand with much biotite	35– 44

210. *Record of commission's well near Morris Park.*

	Feet.
Wisconsin and Tisbury :	
1– 2. Yellow surface loam	0– 1
3– 8. Fine to coarse, grayish-brown, glacial sand	5– 31
9–12. Dark steel-gray sand (glacial)	31– 50.5

211. *Record of commission's test well near Jamaica.*

	Feet.
Wisconsin:	
1– 3. Filled ground	0– 4
4–12. Dark-gray fine sand and gravel with much biotite and erratic material	4– 41
13. Small, multicolored, glacial gravel with much erratic material	41– 43

	Feet.
Tisbury:	
14–27. Dark-gray fine to medium sand	43–106
28–30. Medium to coarse light-yellow sand with a very small percentage of glacial material	106–111
Sankaty:	
31–33. Blue sandy clay	111–122

212. The following section has been prepared from the samples preserved by the Brooklyn water department (see fig. 13):

Record of Brooklyn test well No. 11, near Jamaica.

	Feet.
Wisconsin:	
1. Fine to coarse light sand with some pebbles	0– 3
2. Medium reddish-brown sand	3– 7
3. Same as 1	7– 20
Tisbury:	
4. Fine to coarse reddish-yellow sands (glacial)	20– 43
5. Fine, yellowish-gray, speckled sands (glacial)	43– 89
6. Coarser yellowish gray sand with gravel	89– 95
Sankaty:	
7. Gray clay	95–189
Jameco:	
8. Dark multicolored fine to coarse sand (glacial)	189–200

Elevation of surface, 19.2 feet. Between 190 and 198 feet below the surface large quantities of water were found.

213. Mr. C. A. Lockwood has kindly furnished the following record of a deep well put down at the pumping station of the Jamaica Water Supply Company (see fig. 13):

Record of well at pumping station of Jamaica Water Supply Company, Jamaica.

	Feet.
Wisconsin and Tisbury:	
1. Surface loam	0 – 1.5
2. Sand and gravel	1.5– 60
Sankaty:	
3. Blue clay	60 –104
Jameco:	
4. Coarse sand and reddish gravel	104 –120
Cretaceous:	
5. Blue clay like that in stratum 3	120 –140
6. Coarse sand and gravel lighter in color than preceding	140 –156
7. Blue clay like that in strata 3 and 5	156 –175
8. Coarse gray sand	175 –235
9. "Pretty" red clay	235 –239
10. Lignite	239 –240
11. Very coarse, sharp, nearly white sand	240 –
12. Pink clay of the consistency of putty, described as very beautiful in appearance	241
13. Lignite	241 –242
14. White putty-like clay	242 –243
15. Beach sand	243 –352

Near this well another well was put down to a depth of 330 feet, when work was discontinued because of the great amount of lignite encountered. The first clay bed in the second well was of somewhat less thickness than in the first. Clam shells are reported at various depths. The water in this well contains considerable quantities of iron.

Other wells at the Jamaica pumping station are as follows: One 8-foot brick-curb well 57 feet deep; one 8-inch tile well 50 feet deep; one 10-inch well 150 feet deep. The material above the first layer of clay in these wells varies in different localities from sand and gravel to a red or gray sand and in some places to quicksand.

Mr. Lockwood reports that the capacity of the entire series of wells is 7,000,000 gallons a day, but that only 3,000,000 gallons a day are actually pumped during the summer months, and that the average for the year is from 2,275,000 to 2,500,000 gallons a day. The smallest wells at the station are 5 inches in diameter and out of a single one of these 250,000 gallons a day is pumped.

In 1886 if the 10-inch and 5-inch wells at the station were allowed to remain without pumping, it took the water five seconds to recover its natural level. In 1903 it took four and one-half minutes to recover. In the interval of seventeen years the water level has been lowered about 1 foot.

Analysis of well water from pumping station of Jamaica Water Supply Company, Jamaica.

[By Brooklyn health department, July 31, 1903. Analyst, Richard J. Reilly, assistant chemist.]

	Parts per million.
Appearance	Clear.
Color	None.
Odor (heated to 100° F.)	None.
Sediment	
Chlorine in chlorides	17.00
Sodium chloride	28.01
Phosphates	None.
Nitrogen in nitrites	None.
Nitrogen in nitrates	6.00
Free ammonia	.005
Albuminoid ammonia	.01
Total hardness	83.4
Permanent hardness	75.0
Organic and volatile matter (loss on ignition)	39.0
Mineral matter (nonvolatile)	120.0
Total solids (by evaporation)	159.0

Analysis of well water from pumping station of Jamaica Water Supply Company, Jamaica.

[By Long Island Railroad Company, May, 1897.]

	Parts per million.
SiO_2	17.1
Al_2O_3 and Fe_2O_3	2.39
$CaCO_3$	29.07
$MgCO_3$	16.42
$CaSO_4$	23.77
$MgCl_2$	14.71
NaCl	8.21
Total solids	111.67

214. *Record of commission's test well near Jamaica.*

Wisconsin:	Feet.
1. Surface, dark sandy loam	
2. Subsoil, reddish-yellow loamy sand	
3–4. Yellow silty sand	5.5–11
5–6. Sand and fine gravel	15 –21.5
7–8. Sand bucket sample shows sand with a considerable percentage of fine gravel, and a wash sample shows reddish yellow sand	25 –31

215. *Record of commission's test well near Jamaica.*

Wisconsin:	Feet.
1–2. Surface loam	0 – 1
3–8. Outwash gravel	1 –25.5

See Table XII.

217. *Record of commission's test well near Springland.*

Wisconsin.	Feet.
1–2. Surface loam	0 – 1
3–8. Outwash sand and gravel with much biotite	3 –24.5

See Table XII.

216. *Record of commission's test well near Jamaica.*

Wisconsin:	Feet.
1–2. Yellow surface loam	0– 2
3–5. Outwash material increasing in coarseness with depth	5 –16
Yellowish sandy clay	19.5–20
6–8. Reddish-brown outwash sand and gravel	21 –32

See Table XII.

218. *Record of commission's test well near Queens.*

Wisconsin and Tisbury?:	Feet.
1–2. Yellow surface loam	0– 1
3. Yellow loamy sand	5– 5.5
4–5. Light, grayish yellow, outwash sand and gravel	10–16
6. Fine, dark, steel-gray sand (glacial)	20–21
7–11. Light, grayish yellow, outwash sand and gravel	26–60

See Table XII.

219A. This is a small private, high-service system, which draws its water from the mains of the Jamaica Water Supply Company and supplies an area of about 195 acres.

220. The following section has been prepared from the samples preserved by the Brooklyn water department:

Record of Brooklyn test well No. 7, near Hollis.

Wisconsin:	Feet.
1. Reddish yellow surface loam and loamy sand	0– 15
Wisconsin and Tisbury:	
2. Light, reddish yellow, multicolored sands and gravel (glacial)	15– 69
Tisbury:	
3. Medium-light grayish yellow sand	69– 77
4. Light-yellow sand	77– 98
Cretaceous?:	
5. Very fine, gray, silty clay ("blue clay")	98–103
Cretaceous:	
6. Reddish yellow sand and gravel, with muscovite	103–117
7. Light, yellowish white, medium sands	117–144
8. Darker yellowish white sands	144–157
9. Light, yellowish white, fine to medium sands	157–217
10. White quartz pebbles	217–224
11. Fine to coarse, light, yellowish sands	224–294
12. F ne pink sands	294–297
13. Fine reddish yellow sand	297–302
14. Dark blue-gray clay	302–319
15. Fine gray sand	319–337
16. Very fine pinkish gray sand	337–348
17. Very fine olive-gray sand	348–354
18. Alternate layers of very fine and fine pinkish gray sand	354–369

Cretaceous—Continued.	Feet.
19. Fine light-gray sand	369–401
20. Medium dark-gray sand	401–403
21. Very fine very dark-gray sand	403–407

Elevation, 58.6 feet, Brooklyn base. The samples below No .7 all have cons derable muscovite and resemble the yellow Cretaceous sands of the old Westbury section (well No. 430) and the Melville section in the West Hills.

221. *Record of commission's test well near Woodhull Park.*

Wisconsin:	Feet.
1–2. Yellow surface loam	0– 5.2
3. Very fine dark-gray clayey sand	10–11
4–8. Highly erratic outwash sand and gravel	15–29

See Table XII.

222. *Record of commission's test well near West Jamaica.*

Wisconsin and Tisbury?:	Feet.
1. Surface sandy loam	0–2
2–4. Reddish brown fine to coarse glacial sand	2–20
5–9. Medium gray sand with much biotite	20–52

223. The plant of the Montauk Water Company, situated at Dunton, consists of eighteen 10-inch tile wells having an average depth of 50 feet. The type of the well and the character of strata penetrated is shown in the accompanying figure (fig. 63). Mr. C. A. Lockwood gives the following section of a well completed by him at this point:

Record of Montauk Water Company's well at Dunton.

Wisconsin and Tisbury?:	Feet.
1. Sandy loam	0– 8
2. Blue clay	8–24
3. Coarse gray sand and gravel	24–64

The following analyses were reported by the Long Island Railroad Company, April, 1897, and September, 1901, respectively:

Analyses of water from Montauk Water Company's well at Dunton.

	Parts per million.
SiO_2	19.15
Al_2O_3 and Fe_2O_3	.51
$CaCO_3$	42.07
$MgCO_3$	23.08
$CaSO_4$	10.09
$MgSO_4$	.51
$MgCl_2$	14.19
NaCl	4.96
	114.56
SiO_2, etc	20.35
$CaCO_3$	54.55
$MgCO_3$	25.65
$CaSO_4$	13.00
$MgSO_4$	7.69
$MgCl_2$	16.42
NaCl	13.00
	150.66

An excellent boiler water, but forms some scale.

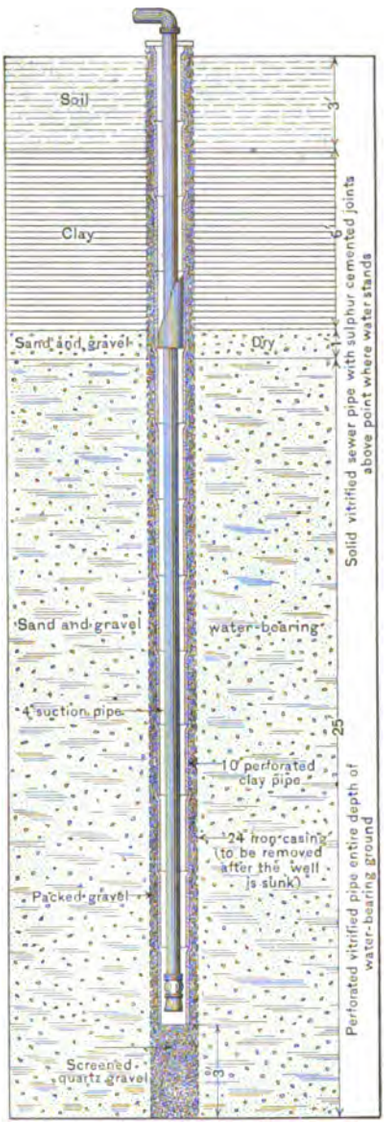

FIG. 63.—Type of well used at the Montauk waterworks plant at Dunton, N. Y.

Analysis of water from Montauk Water Company's well at Dunton.

[Analyst, H. B. Hodges.]

	Parts per million
Silica oxide of iron and alumina	11.97
Carbonates of lime and magnesia	77.98
Sulphate of lime and magnesia	22.06
Chlorides	39.50
Soluble sulphates	51.98
Total solids	203.49

224. *Record of commission's test well near Willow Glen.*

Wisconsin:	Feet.
1. Humus-stained clay	0.0– 0.5
2. Reddish yellow clay	.7– 1
3–4. Very fine, reddish-yellow, clayey sand	7 –14
5–6. Very fine, dark-gray, glacial sand	19 –25

225. The average section at this point is reported as follows:

Record of wells of Citizens' Water Supply Company at head of Flushing Creek.

Wisconsin and Tisbury?:	Feet.
1. Bluish clay and stones	0–18
2. Coarse brown sand and gravel	18–45
3. Fine brown sand	45–

Water below 50 feet is poor.

226. Mr. Edgar L. Wakeman, proprietor of the Deep Glen Spring, reports that in 1903 between 2,000 and 2,500 gallons of this spring water were placed on the market every week, having a value of from $200 to $250.

Analysis of water of Deep Glen Spring, near Flushing.

	Parts per million.
Sodium chloride	26.3940
Sodium bromide	.0360
Sodium iodate	.0051
Sodium and potassium sulphate	2.8272
Sodium carbonate	6.5040
Strontium carbonate	.0022
Calcium	1.5851
Magnesium	.5147
Iron	.0955
Silica	.7517
Organic and volatile matter	Trace.

227. *Record of commission's test well north of Jamaica.*

Wisconsin:	Feet.
1. Black, humus-stained, gravelly loam	0– 0.5
2. Yellow gravelly loam	1– 1.5
3–4. Reddish yellow clayey sand	5–11
5–8. Dark, grayish brown, fine to medium sand	15–31
9–11. Dark, multicolored, glacial sand and gravel	35–46

228. *Record of well between Queens and Bayside.*

Wisconsin and Tisbury:	Feet.
1. Loam and loamy clay	0–50
2. Sand and gravel	50–86

229. *Record of commission's test well near Flushing.*

Wisconsin:	Feet.
1–8. Yellowish gray sand of probable outwash origin	0–31
9. Yellowish gray sand with small percentage of clay	34–35

See Table XII.

230. This well flows 12 or 14 inches above the top of the ground. It is just below the dam of the ice pond, and Mr. Sweeney believes that this is possibly responsible for the head.

Record of well of Casino Lake Ice Company at Casino Lake, near Flushing.

	Feet.
1. Black mud	0– 5
2. Compact mixture of sand and gravel	5–13
3. Clean coarse red sand	13–35
4. Pure-white quartz gravel	35–40

231. This is the old College Point municipal plant, which was built in 1874–75 at the Kassena spring south of Flushing.[a] It has now been decided to replace or supplement the spring supply by driven wells. The following sections of 3 test wells are reported by Mr. C. D. Corwin:

Record of test well No. 1, Fresh Meadow pumping station, south of Flushing.

	Feet.
1. Black silty mud	0.0– 2.6
2. Yellow clay with stones	2.6– 5
3. Sand and gravel	5 –10
4. Yellow sand	10 –12
5. Medium gray sand	12 –24
6. Fine yellow sand	24 –26
7. Yellow medium sand with water	26 –40
8. Coarse yellow sand	40 –55
9. Yellow and white clay and fine sand	55 –65
10. Yellow clay and fine sand	65 –75
11. Fine white sand; flowed slightly	75 –80

At 49 feet flowed 1½ gallons per minute 24 inches above ground. Brook is 9 inches higher than pond. Temperature of water of well, 56°; of pond, 44°.

Mr. Corwin has furnished the following samples from this well:

Record of test well No. 1, Fresh Meadow pumping station, south of Flushing.

	Feet.
Wisconsin or Tisbury:	
1. Clean, orange-colored, quartz sand and small gravel, with considerable percentage of glacial material	49
Mannetto or Cretaceous:	
2–3. Very coarse orange sand and small gravel; quartz with a small percentage of decayed white chert, which suggests Cretaceous or Mannetto	50–57
Cretaceous ?:	
4. Medium white quartz sand, with much muscovite	57–85

Record of test well No. 2, Fresh Meadow pumping station, south of Flushing.

	Feet.
1. Black silty mud	0.0– 2.6
2. Yellow clay with stones	2.6– 5
3. Sand and gravel	5 –10
4. Yellow sand	10 –12
5. Medium gray sand	12 –24
6. Fine yellow sand	24 –26
7. Medium yellow sand, water-bearing	26 –55
8. Coarse yellow and white sand, mixed	55 –57
9. White sand and clay	57 –80

[a] Fire and Water Engineering, vol. 23, 1898, p. 91.

Record of test well No. 3, Fresh Meadow pumping station, south of Flushing.

	Feet.
1. Gray sand with stones	4– 9
2. Hardpan; clay and stones	9–20
3. Medium sand with little water	20–28
4. Medium dark sand	28–35
5. Medium gray sand with water	35–40
6. Medium sand, darker	40–55

232. *Record of commission's test well near Flushing.*

Wisconsin:	Feet.
1–2. Surface loam	0– 3.5
3–7. Yellow silty sand and bowlders	5–26
8–9. Fine sand to small gravel, dark, multicolored	30–33

233. *Record of commission's test well near Broadway.*

Wisconsin:	Feet.
1. Yellow sandy loam	0– 6
4. Fine, dark yellowish, clayey, silty sand	10–11
5–6. Dark multicolored sand and gravel; large percentage of erratics	14–20
7–11. Dark, yellowish brown, fine to medium sand with considerable mica	21–40

234. *Record of commission's test well at Queens avenue and Rocky Hill road.*

Wisconsin:	Feet.
1–2. Dark loamy sand and gravel	0– 1.5
3–8. Glacial sand and gravel with a very large percentage of fresh glacial material	5–30
Wisconsin and Tisbury:	
9. Dark, reddish brown, fine to coarse micaceous sand (apparently glacial)	33–34
Tisbury:	
10–11. Fine to coarse yellow sand (glacial)	37–41

235. *Record of commission's test well near Auburndale.*

Wisconsin:	Feet.
1–3. Yellow loamy sand	0– 6
4–8. Dark yellowish brown sand and gravel of glacial origin	10–27
9. Dark silty sand formed from drilling in rock	28–28.5
10–11. Multicolored, glacial, gravel till	30–38

See Table XII.

236. *Record of commission's test well near Bayside.*

Wisconsin:	Feet.
1. Yellowish brown surface loam	0.5– 1
2–3. Reddish loamy sand	2– 6
4. Yellowish brown silt to fine gravel (glacial)	10–11
5. Yellowish clayey sand	15–16
6. Black clayey sand	17–18
Wisconsin and Tisbury:	
7–14. Dark reddish brown sand and gravel (pronouncedly glacial)	19–55
Tisbury:	
15. Light, reddish yellow, medium sand	56–57
16. Grayish white sand and gravel with a very small percentage of glacial material	60–61
Cretaceous?	
17. Medium grayish yellow sand with muscovite (probably not glacial)	63–64

237. *Record of commission's test well near Bayside.*

Wisconsin:	Feet.
1–2. Yellow sandy clay	0– 2
3–4. Yellow clayey sand with some pebbles	3– 5.5
5–6. Dark clayey sand	10–18
7–10. Mottled sand and gravel (pronouncedly glacial)	20–29.5
11. Multicolored sand and gravel similar to that found below the blue clay on the south shore	35–36

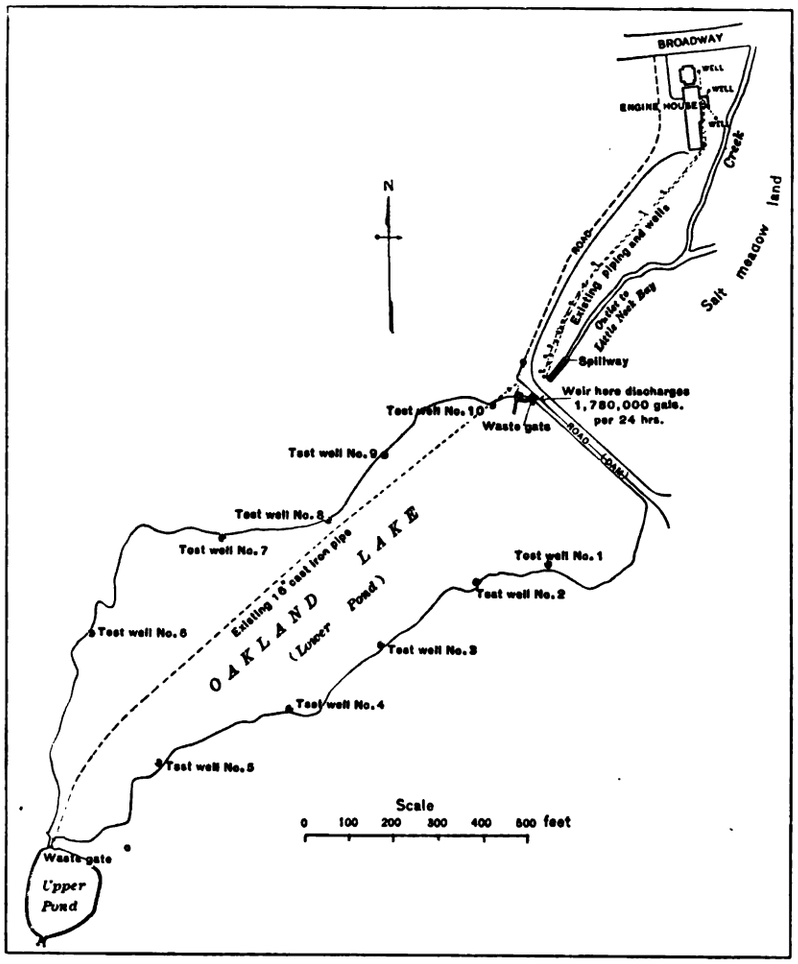

FIG. 64.—Sketch map showing location of test borings at Bayside pumping station.

12–13. Dark yellowish clayey sand (glacial)	40–46
14–16. Dark, multicolored, fine to coarse sand (glacial)	49–65
Tisbury:	
17. Fine to coarse yellow sand with very little glacial material	65–66
Tisbury?:	
18. Yellow sand and small gravel with many fragments of ferruginous concretions	70–71

238. The 21 wells which now supply the Bayside pumping station are all finished in glacial sand and gravel of Wisconsin or Tisbury age. The engineer at the station reports that the wells will begin flowing about five hours after pumping is stopped. Ten test wells were put down several years ago around the edge of Oakland Lake just above the pumping station; the material penetrated is shown in the following table, which was prepared from the samples by Mr. Alexander S. Farmer. The location of the wells is shown on the accompanying sketch map, fig. 64.

Description of samples from test borings at Bayside pumping station.

[By Alexander S. Farmer.]

Test boring No.	Composition of soil at a depth of—			
	5 feet.	10 feet.	15 feet.	20 feet.
1	Sand, brown, mixed with black; fine quartz grains.	Sand, brownish white, mixed with black; coarse and fine quartz grains.	Sand, brownish white, mixed with a little black; coarse grains, homogeneous in character. Water bearing?	Sand, white with brownish tinge; fine quartz grains, homogeneous in character.
2	Sand, brown, mixed with black; coarse and fine quartz grains.	Sand, brown, mixed with black; coarse and fine quartz grains.	Sand, white with brownish tinge; very fine quartz grains, homogeneous in character.	Sand, white with brownish tinge; very fine quartz grains, homogeneous in character.
3	Sand, brown; coarse grains $\frac{1}{16}$ to $\frac{1}{4}$ inch in diameter in a matrix of finer quartz grains; porphyritic in character. Water bearing?	Sand, brown; coarse quartz grains $\frac{1}{16}$ to $\frac{1}{4}$ inch in diameter in a matrix of finer grains; porphyritic in character. Water bearing?	Sand, light brown; fine quartz grains mixed with some coarse ones.	Sand, light brown; fine quartz grains mixed with some coarse ones.
4	Sand, brown; coarse grains in finer matrix.	Sand, brown; coarse grains in finer matrix.	Clay, white.....	Clay, white.
5	Sand, light brown; coarse grains in finer matrix; porphyritic in character.	Sand, light brown; coarse grains in finer matrix; porphyritic in character.	Small gravel $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter, cemented in brownish-white clay matrix; porphyritic structure.	Sand, cemented in slate-colored clay matrix.
6	Sand, light brown; coarse grains. Water bearing?	Sand, light brown; coarse grains, $\frac{1}{16}$ to $\frac{1}{4}$ inch diameter, mixed with finer ones; porphyritic character. Water bearing?	Sand, light brown; coarse grains, $\frac{1}{16}$ to $\frac{1}{4}$ inch diameter, mixed with finer ones; porphyritic character. Water bearing?	Sand, light brown; coarse grains, $\frac{1}{16}$ to $\frac{1}{4}$ inch diameter, mixed with finer ones; porphyritic character. Water bearing?
7	Sand, brown; coarse grains containing some mica; homogeneous in character.	Sand, light brown; contains some black; very fine grains; mica present; homogeneous in character.	Sand, light brown; coarse grains in finer matrix; mica present; porphyritic in character. Water bearing?	Sand, light brown; fine grains; mica present; homogeneous in character.
8	Sand, light brown; coarse grains in finer matrix.	Sand, light brown; coarse grains in finer matrix. Water bearing?	Sand, light brown; coarse grains in finer matrix. Water bearing?	Sand, light brown; coarse grains in finer matrix. Water bearing?
9	Sand, light brown; coarse grains, $\frac{1}{16}$ to $\frac{1}{8}$ inch diameter, in finer matrix; mica present; porphyritic character. Water bearing?	Sand, light brown; coarse grains, $\frac{1}{16}$ to $\frac{1}{8}$ inch diameter, in finer matrix; mica present; porphyritic character. Water bearing?	Sand, light brown; coarse grains, $\frac{1}{16}$ to $\frac{1}{8}$ inch diameter, in finer matrix; mica present; porphyritic character. Water bearing?	Sand, light brown; fine grains, homogeneous in character.
10	Sand, buff colored; fine grains approaching clay in composition.	Sand, buff colored; fine grains approaching clay in composition.	Sand, light brown; fine grains, homogeneous in character.	Do.

Test boring No.	Composition of soil at a depth of—			
	25 feet.	30 feet.	35 feet.	40 feet.
1	Sand, white with brownish tinge; very fine quartz grains, homogeneous in character.	Sand, almost white; very fine quartz grains, homogeneous in character.	Sand, almost white; very fine quartz grains, homogeneous in character.	Sand, white with brownish tinge; coarse quartz grains, $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter, mixed with coarse and fine grains; porphyritic in character. Water bearing?
2	Sand, white with brownish tinge; fine quartz grains, homogeneous in character.	Sand, brownish white; coarse quartz grains, homogeneous in character. Water bearing?	Sand, brownish white; coarse and fine quartz grains.	Sand, light brown; very fine quartz grains, homogeneous in character.

Description of samples from test borings at Bayside pumping station—Continued.

Test boring No.	Composition of soil at a depth of—			
	25 feet.	30 feet.	35 feet.	40 feet.
3	Sand, light brown; very fine quartz grains, homogeneous in character.	Sand, brown; coarse quartz grains, homogeneous in character. Water bearing?	Gravel, brown; grains averaging $\frac{1}{8}$ inch in diameter, homogeneous in character. Water bearing?	Sand, light brown; very fine grains mixed with coarse ones.
4	Sand, light brown; very fine grains, homogeneous in character.	Sand, very light brown; very fine grains, homogeneous in character.	Gravel, light brown; grains averaging $\frac{1}{8}$ inch in diameter, homogeneous in character. Water bearing?	Sand, light brown; fine grains mixed with coarse ones.
5	Sand, cemented in slate-colored clay matrix.	Sand, light brown; coarse grains, homogeneous in character. Water bearing?	Sand, brownish white; very fine grains; resembles sea sand; homogeneous in character.	Sand, light brown; very fine grains, homogeneous in character.
6	Sand, light brown; coarse grains, $\frac{1}{16}$ to $\frac{1}{4}$ inch diameter, mixed with finer ones; porphyritic character. Water bearing?	Sand, light brown; coarse grains, $\frac{1}{16}$ to $\frac{1}{4}$ inch diameter, mixed with finer ones; porphyritic in character. Water bearing?	Sand, light brown; coarse grains, $\frac{1}{16}$ to $\frac{1}{4}$ inch diameter, mixed with finer ones; porphyritic in character Water bearing?	Sand, light brown; fine grains mixed with coarse ones.
7	Grains averaging $\frac{1}{16}$ inch in diameter, cemented to some extent in grayish-white clay matrix.	Clay, grayish white.....	Sand, light brown; fine grains, homogeneous in character.	Sand, light brown; fine grains, homogeneous in character.
8	Sand, light brown; coarse grains in finer matrix. Water bearing?	Sand, light brown; coarse grains in finer matrix. Water bearing?	Sand, light colored; very fine grains approaching clay in composition.	Sand, light colored; very fine grains, homogeneous in character.
9	Sand, light brown; fine grains, homogeneous in character.	Sand, light brown; coarse grains, $\frac{1}{16}$ inch diameter, in finer matrix. Water bearing?	Sand, gray; large grains, $\frac{1}{4}$ inch diameter, in finer matrix; porphyritic in character. Water bearing?	Sand, light brown; coarse grains in finer matrix. Water bearing?
10	Sand, blackish brown; coarse grains, homogeneous in character. Water bearing?	Sand, white; very fine grains containing coarse ones; resembles sea sand.	Saad, light brown; coarse grains in finer matrix.	Sand, light brown; fine grains, homogeneous in character.

Test boring No.	Composition of soil at a depth of—			
	45 feet.	50 feet.	55 feet.	60 feet.
1	Sand, brownish white; coarse, differentiating to fine quartz grains. Water bearing?	Sand, brownish white; coarse quartz grains, homogeneous in character. Water bearing?	Clay, yellowish white.....	Clay, yellowish white.
2	Sand, light brown; very fine quartz grains, homogeneous in character.	Sand, light brown; very fine quartz grains, homogeneous in character.	Sand, light brown; very fine quartz grains, homogeneous in character.	Sand, light brown; very fine quartz grains, homogeneous in character.
3	Sand, light brown; very fine grains mixed with coarse ones.	Sand, light brown; very fine grains mixed with coarse ones.	Sand, light brown; coarse grains in finer matrix.	Sand, very light brown; fine grains mixed with coarse ones.
4	Clay, yellowish white.....	Clay, yellowish white.....	Clay, yellowish white.....	Clay, yellowish white.
5	Sand, light brown; very fine grains, homogeneous in character.	Sand, light brown; very fine grains, homogeneous in character.	Sand, light brown; fine grains mixed with coarse ones.	Sand, light brown; fine grains mixed with coarse ones.
6	Sand, light brown; fine grains mixed with coarse ones.	Sand, light brown; fine grains mixed with coarse ones.	.....do.....	Do.
7	Sand, light brown; fine grains, homogeneous in character.	Clay, grayish white.....	Clay, light drab.....	Clay, light drab.
8	Sand, almost white; resembles sea sand; much mica present.	Sand, grayish white; very fine grains; on the border line between clay and sand.	.....do.....	Do.
9	Sand, light brown; coarse grains in finer matrix. Water bearing?	Sand, light colored; fine grains containing some coarse ones.	Sand, grayish white; almost clay; impalpable character.	Sand, grayish white; almost clay; impalpable character.
10	Sand, light brown; fine grains, homogeneous in character.	Clay, grayish white.....	Clay, grayish white.....	Clay, grayish white.

239. The following section has been prepared by Mr. Alexander S. Farmer:

Record of well at pumping station No. 1, Whitestone.

	Feet.
Wisconsin and Tisbury:	
1. Water-bearing sand and gravel	0–25
Sankaty:	
2. Blue clay	25–45
Jameco:	
3. Water-bearing glacial sand and gravel	45–95
Cretaceous?:	
4. Clay	95–

240. This well was driven in the bay 100 feet from the shore; at high tide it is covered with from 12 to 14 feet of water.

Record of well of McWilliams Coal Company near Whitestone Landing.

	Feet.
Recent:	
1. River mud	0– 6
Cretaceous:	
2. Blue, white, and red clay, arranged in alternate layers, but containing no sand or gravel	6–175

241. Four test wells were put down to depths ranging from 90 to 120 feet; in all of them the water was found to be brackish, and the wells were abandoned. The tops of the wells are about 15 feet above high tide level, and the water in them fluctuates with the tide, to an amount thought by the driller to be almost equal to that in the bay; they are situated about 400 feet from the water's edge.

Record of railroad wells near Whitestone Landing.

	Feet.
Recent:	
1. Coarse, sandy, marsh material and "muck"	0– 15
Tisbury:	
2. White beach sand	15– 60
Sankaty:	
3. Clay	60– 85
Jameco:	
4. Coarse varicolored gravel	85–120

242. This was formerly a private plant from which the water was pumped into a ground reservoir on the hill behind it. It was later acquired by the city, and is now used only as a reserve station.

243. Stotthoff Brothers report the following section for this well:

Record of W. W. Cole's well near Whitestone.

	Feet.
1. Dug well	0–16
Sankaty?:	
2. Clay	16–56
Sankaty? and Jameco?:	
3. Quicksand	56–70
Jameco:	
4. Medium, coarse, water-bearing gravel	70–96

244. No definite information has been obtained regarding the deep well at this point, other than that it is about 500 feet deep. The depth to bed rock, which is an interesting point, because this well is in the line of the old Sound River Valley, is likewise not obtainable. It was reported from one source as being about 10 feet above sea level, but Maj. Edward Burr, of the Corps of Engineers, reports that the excavations at this point have not shown rock at such a height.

246. *Record of H. B. Gilbert's well near Great Neck, Elm Point.*

	Feet.
Wisconsin:	
1. Yellow clay with bowlders	0– 12
Tisbury:	
2. Gray sand	12– 24
3. Rusty gravel	24– 56
Tisbury?:	
4. Fine canary-colored sand	56– 66
5. No record	66–103
6. Coarse sand and gravel, water bearing	103–114

A near-by dug well encountered water at 26 feet, evidently in layer No. 3. This dug well goes dry in dry seasons.

247. *Record of J. E. Martin's well near Great Neck, Elm Point.*

	Feet.
Wisconsin:	
1. Yellow clay with bowlders	0–22
2. Hardpan clay with small cobbles	22–30
Tisbury:	
3. Gray sand, passing below into gravel about the size of shelled corn	30–67

249. Mr. J. H. Herbert has kindly furnished the following samples from this well:

Record of H. B. Gilbert's well near Great Neck, Elm Point.

	Feet.
Wisconsin:	
1-2. Red sandy clay (glacial)	6–11
Cretaceous:	
3. Fine white sand with lignite	13
4. Very fine, white, sandy clay	17
5. Fine gray sand and lignite	19–24
6. Gray laminated clay	60

The well was abandoned at this point and a new well (248) sunk at a distance of about 300 yards, where a good supply was obtained in glacial gravel.

251. The driller reports a dry hole at 65 feet, and water at 66. The well is about 6 feet above high tide near the beach, and it is stated that a float placed in this well did not fluctuate with the tide.

Record of H. C. Childs's well near Hewlett Point.

	Feet.
Wisconsin:	
1. Surface loamy sand	0–3
Wisconsin and Cretaceous?:	
2. Gray sand	3–26
Cretaceous?:	
3. Blue clay	26–29
4. Quicksand	29–35
5. Coarse gray sand, dry	35–65
6. Clay	65–65.5
7. Gravel with water	65.5–66

252. Mr. Herbert reports having sunk a 6-inch pipe 40 feet in the bottom of a 52-foot dug well; he then encountered hard rock (probably a bowlder) and discontinued the work. The material penetrated was all quicksand and gray beach sand.

254. It is stated that Mr. Griffin had 17 wells put down at his place without success; one on the edge of the beach, about 200 yards north of well No. 251, is reported to have been 90 feet deep and to have found no water. The well completed by Mr. Herbert furnishes a good supply of water. The material encountered in this well is as follows:

Record of C. L. Griffin's well near Hewlett Point.

	Feet.
1. Top soil	0–3
2. Blue clay	3–26
4. Quicksand	26–
5. Light-gray hardpan	
6. Gray gravel	–68

255. *Record of W. H. Arnold's well near Hewlett Point.*

	Feet.
1. Hard dark-colored earth	0–16
2. Yellow sandy clay	16–28
3. Blue clay with sand	28–
4. Gray sand	–132
5. Blue clay	132–150
6. Gray gravel	150–159

256. Stotthoff Brothers, in letter dated April 30, 1903, report the following: "The well is 512 feet deep, and 8 inches in diameter; the first 90 feet light gray sand with coarse seams, 5 to 20 feet apart, and from 6 inches to 2 feet thick; there being enough clay to hold the sand so that it would hold itself while driving the pipe; the next 140 feet fine gray sand and quicksand very fine and uniform to top of rock; no water. Rock from 230 to 512 feet, soft gray granite and mica veins, same character as is found throughout Westchester County, N. Y."

257. *Record of Mrs. M. E. Scott's well at Hewlett Point.*

	Feet.
1. Dug well	0–38
2. Stony clay	38–68
3. Blue clay and quicksand	68–164

The well was abandoned at 164 feet.

258. *Record of G. B. Wilson's well near Hewlett Point.*

	Feet.
1. Dug well (fresh water, slightly hard)	0–14
2. Beach sand	14–20
3. Light-colored clay with stone	20–30
4. Quicksand	30–32
5. Stony clay	32–36
6. Coarse gray sand containing salt water at 46 feet, and brackish water at 59 feet	36–59
7. Alternate layers of sand and clay	59–63
8. Yellowish sand	63–65
9. Blue clay	65–
10. Fine yellow and grayish sand	–103
11. Hardpan	103–105
12. Yellow gravel with fresh water	105–108

259. *Record of well of Lawrence Beach Bathing Association, at Lawrence Beach.*

	Feet.
Recent to Tisbury:	
1. Sand	0–25
Sankaty:	
2. Clay	25–55
Jameco:	
3. Gravel	55–62

260. *Record of John Lawrence's well, on Isle of Wight, New York.*

	Feet.
Recent and Tisbury:	
1. Fine beach sand and clay mixed	0–20
2. Sand and gravel	20–40
Sankaty:	
3. Sand and clay	40–100

The well was completed at 30 feet, this being the best gravel layer encountered.

261. Mr. Gilbert Baldwin, who was in charge of the sinking of this well, gives the following record:

Record of D. D. Lord's well near Lawrence.

	Feet.
Tisbury:	
1. Fine sand	0–31
Sankaty:	
2. Clay, containing few small stones	35–50
3. Sand, containing shells, like clam and oyster shells	50–70
Jameco:	
4. Coarse sand changing to gravel	70–100

The contractor, Mr. Jesse Conklin, under date of April 25, 1895, gives the following data: "At Lawrence I drove a 6-inch well 107 feet; I struck water at 5 feet; drove 25 feet in water and got a good supply; struck blue clay at 30 feet; drove 25 feet through it and struck fine sand and some oyster shells, continuing 30 feet; at 90 feet I struck white gravel, drove 17 feet in this and got an unlimited supply of water."

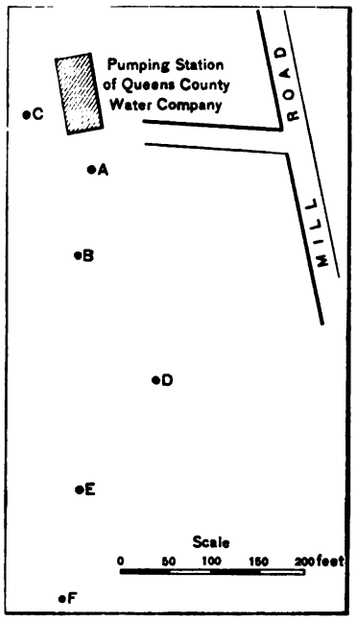

FIG. 65.—Sketch map giving locations of wells of the Queens County Water Company shown in fig. 66.

262. *Record of A. W. Hart's well near Lawrence.*

	Feet.
Tisbury:	
1. Yellow sand and gravel	0–40
Sankaty and Jameco:	
2. Grayish clay, no pebbles	40–60
3. Coarse white sand mixed with a little clay (some oyster shells found in this sand).	60–70

263. Mr. Edward Man gives the following data regarding this well: "At a depth of 416 feet I struck a plentiful supply of bright clear water, which, however, was exceedingly salt. It contained quite a large amount of iron, and had a slight odor of sulphureted hydrogen. In my opinion this water contained considerably more salt than the ocean itself. The water rose in the pipe to within about 15 feet of the surface.

"In driving the well I encountered a water-bearing layer at about 40 feet and another at about 150 feet; these I should judge to have been about 3 feet in thickness. The first layer yielded a bright, clear, fresh water, pleasant to the taste, and apparently free from any iron, but was unfortunately found, after being used for several years, to be 'contaminated with sewage to a marked degree,' according to the report of Mr. Vulte, Professor Chandler's assistant at Columbia College.

"At 150 feet there was another water-bearing layer, which yielded a plentiful supply of bright clear water, but as soon as the water was exposed to the air, the iron in it seemed to be chemically changed by the light and air and the water became quite brown, so that it could not be used for washing. This water when filtered through a Gate City stone filter was entirely free from any appearance or taste of iron, so that I think the iron in it was not in solution but in suspension."

This is the well reported by Darton as "Lawrence: Depth 205 feet; capacity 35 gallons; water layer at 40 feet." It has since been deepened.

265. Mr. Walsh reports that in the vicinity of Cedarhurst he usually encounters streaks of hard pan 6 inches thick at 22 or 25 feet below the surface. The hard pan is described as a mixture of brown clay and coarse gravel, packed closely together and cemented with iron.

Record of Judge Diver's well near Cedarhurst.

	Feet.
1. Sandy loam	0– 3
2. Sand similar to that elsewhere on the Rockaway Ridge	3–25
3. Coarse sand and gravel	25–35

266. *Record of Dr. Anderson's well near Cedarhurst.*

	Feet.
Tisbury:	
1. Yellow sand	0–42
2. Gravel	42–

267. *Record of Louis Touscher's well near Cedarhurst.*

	Feet.
Tisbury:	
1. Fine white sand	0–37
2. Gravel	37–

268. *Record of Samuel Brower's well near Brower Point.*

	Feet.
Tisbury:	
1. Sand	0–17
2. Quicksand; very fine	17–27
3. Sand and gravel; coarseness increasing with depth	27–35

272. Mr. Jaegle reports that the marsh deposits in this well were about 10 feet thick, below which there was 15 feet of fine dark-colored sand, the remainder of the well being through an alternation of lead-colored sand and clays. A small flow was obtained at 150 feet; at 228 feet a coarse gravel was encountered, from which a good supply of pure water was obtained, flowing 3 feet above the surface of the meadow. A sample of the water-bearing sand from a depth of 228 feet, presented by Mr. Jaegle, is composed of small white quartz pebbles, with a very considerable percentage of erratic material.

273. Mr. Charles R. Bettes, chief engineer, reports that there were in use at this station in the summer of 1903 thirty-two 4- and 5- inch wells 33 feet deep and nineteen 6-inch wells 150 to 190 feet deep. The average daily pumping in 1902 was 1,634,000 gallons, the minimum 850,000 gallons, and the maximum 4,500,000 gallons. One of the new 6-inch test wells completed in 1903 tested 800,000 gallons per day. The water is pumped from the wells to a filter which removes the excess of iron, and is then pumped into mains.

Samples obtained from one of the 6-inch wells drilled during the summer of 1903 show the following section:

Record of well at Queens County pumping station.

	Feet.
Wisconsin:	
1. Gray silty sand and gravel, with a large percentage of biotite	6– 10
Tisbury:	
2–3. White to light-yellow quartz sand and gravel, with only a small percentage of glacial material	10– 32
Sankaty?:	
4. Blue gravelly clay	33– 35
5. Dirty-gray sand and gravel	35– 54
Sankaty:	
6. Blue clay	54– 76
7–10. Fine, gray, pepper-and-salt sand, composed of a mixture of white quartz and green sand, weathering to a reddish yellow	76– 95
Sankaty and Jameco:	
11–12. Light yellowish white sand and gravel; no greensand	95–100
13. Lignite	110
14. Fine pepper-and-salt sand, composed of mixture of white quartz and greensand, containing a little gray clay	115

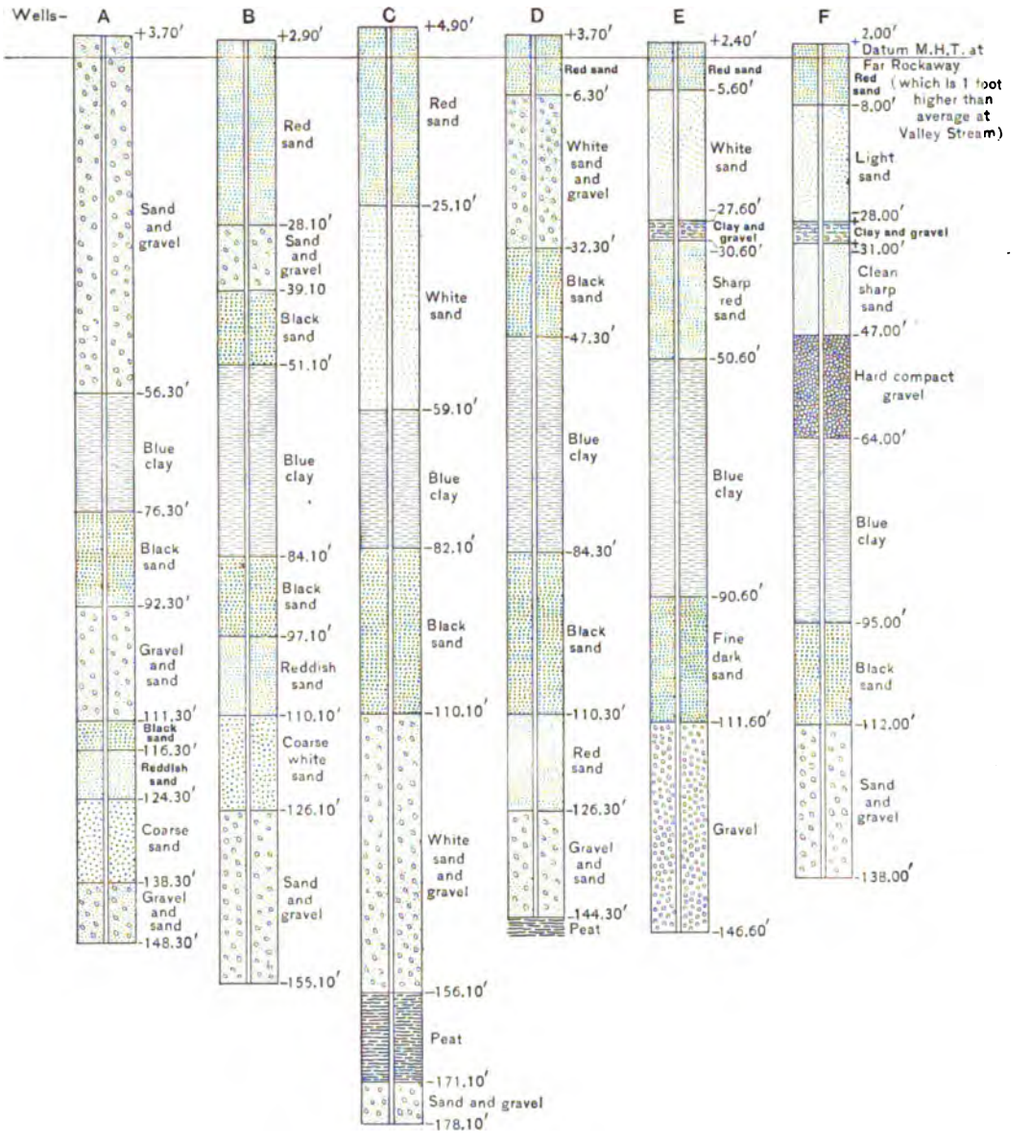

FIG. 66.—Sections of wells of the Queens County Water Company, by Charles R. Bettes, chief engineer. (For locations of wells see fig. 65.)

Jameco:	Feet.
15–19. Light-colored, coarse sand and gravel containing a considerable percentage of erratic material	120–155

Records of the first five wells are shown in fig. 66; for general relations see fig. 13.

Analysis of water from Queens County pumping station.

[Analysis by C. F. Chandler, September 17, 1902.]

	Parts per million.
Chlorine in chlorides	4.100
Sodium chloride	6.766
Phosphates (as P_2O_5)	None.
Nitrogen in nitrites	None.
Nitrogen in nitrates	.010
Free ammonia	.048
Albuminoid ammonia	.018
Total nitrogen	10.064
Hardness:	
Before boiling	15.780
After boiling	10.520
Organic and volatile (loss on ignition)	12.000
Mineral matter (nonvolatile) CO_2 restored with ammonium carbonate	34.500
Total solids (by evaporation) dried at 110° C	46.500
Appearance	Slightly turbid.
Color	Slightly yellowish on account of sediment.
Odor (heated to 100° F)	None.
Taste	None.

The Long Island Railroad Company report the following analysis of water taken from the mains of the Queens County Water Company at Rockaway Beach, May, 1897:

Analysis of water of Queens County Water Company at Rockaway Beach.

	Parts per million.
SiO_2	14.71
Al_2O_3 and Fe_2O_3	3.42
$CaCO_3$	Trace.
$MgCO_3$	4.10
$CaSO_4$	8.04
$MgCl_2$	4.62
NaCl	2.22
Total	37.11

274. Mr. Walsh reports that at a depth of 50 feet layers of lignite and mud were encountered, in which were found "snail shells, skimmer shells, and razor shells." (See fig. 13.)

Record of well near Hewlett.

Tisbury:	Feet.
1. Sand and gravel similar to material elsewhere on Rockaway Ridge	0–13
Sankaty:	
2. Blue clay	13–21
Sankaty and Jameco:	
3. Fine sand with no available water	21–70
4. Good water-bearing sand	70– 0

275. *Record of Mrs. Julia Flower's well near Lynbrook.*

	Feet.
Tisbury:	
1. Brown to red sand and gravel	0– 13.5
Sankaty and Cretaceous:	
2. Perfectly dry blue clay; no stones	17– 80
3. White clay, which became creamy under the action of the wash pipe	80– 82
4. White sand	82– 90
5. Blue clay similar to that in section 2	90–130
6. Fine sand, somewhat clayey from clay above	130–135
7. Sand, changing gradually to white gravel. (This layer was water bearing, but the water had a puckerish taste, like alum.)	135–155
8. A blue dry clay, similar to that in sections 2 and 5	155–180

277. Through the kindness of Mr. Franklin B. Lord, president of the Queens County Water Company, and Mr. Chas. R. Bettes, chief engineer, self-recording gages were placed on three wells at this point: One 504 feet deep, another 74, and the third 14 feet deep. A portion of the results of this work is shown in Pl. XVIII; a detailed report may be expected later. Mr. Lord reports that in 1903 the deep well was pumped at the rate of from 36,000 to 44,000 gallons for twenty-four hours, for a period of twenty-four and one-fourth hours, with three stops of fifteen minutes each. This reduced the level of the water 3.92 feet; it returned to its normal level in seventy minutes after the pumping was stopped. During this test the level of the water in the 74-foot well was not reduced, and the 504-foot well was not affected by the pumping of the shallower well. On February 13, 1903, the 74-foot well was given a five-hour test, and the level of the water was reduced more than 22 feet; it regained its normal level in eighteen minutes. In December, 1903, a new well was started at this place from which Mr. Bettes has furnished the following samples:

Record of Queens County Water Company's well at Lynbrook.

	Feet.
T'sbury:	
1. Coarse yellow quartz sand; no erratic material	0– 29
2. Light-gray sand	29– 31
3. Same as No. 1	31– 73
Cretaceous?:	
4. Light-gray silty clay	73– 89
5. Light-yellow medium sand; no erratic material	89–150
Cretaceous:	
6. Fine to medium gray, lignitic sand	150–158
7. Very fine black, micaceous, lignitiferous silt	158–200
8–9. Very fine, dark-colored, lignitiferous sand	200–228
10. Medium light-gray sand with small amount of lignite	228–340
11. Dark-colored, lignitiferous, silty clay	340–363
12. Medium dirty-yellow sand, lignitic	363–403
13. Medium to coarse gray sand	403–536

Analysis of water from wells of Queens County Water Company at Lynbrook.

[By F. C. Chandler, February 25, 1903. Parts per million.]

	504-foot well.	72-foot well.
Appearance	Clear.	Faint milkiness.
Color	None.	None when filtered.
Odor (heated to 100° F.)	None.	None.
Taste	None.	None.
Chlorine in chlorides	3.000	9.000
Sodium chloride	4.950	14.851
Phosphates (as P_2O_5)	None.	None.
Nitrogen in nitrites	None.	None.
Nitrogen in nitrates	.014	.562
Free ammonia	.022	.016
Albuminoid ammonia	.026	.006
Total nitrogen	.053	.580
Hardness:		
Before boiling	8.855	13.915
After boiling	3.795	8.855
Organic and volatile (loss on ignition)	2.000	5.000
Mineral matter (nonvolatile), CO_2, restored with ammonium carbonate	13.500	40.500
Total solids (by evaporation) dried at 110° C.	15.500	45.500

278. The following record is taken from a blueprint kindly furnished by Chief Engineer I. M. De Varona:

Record of Brooklyn test well No. 24.

	Feet.
Wisconsin and Tisbury:	
1. Top soil	0– 4
2. Yellowish sand, water bearing	4– 20
3. Gray sand, water bearing	20– 28
4. Gray sand with little gravel, water bearing	28– 36
5. Fine gray sand	36– 40
6. Yellowish sand and gravel	40– 44
7. Yellowish sand and gravel; traces of clay	44– 58
8. Sand, clay, and large gravel	58– 68
Tisbury? :	
9. Sharp yellow sand with traces of clay	68– 78
Cretaceous? :	
10. Gray sand and clay	78– 88
11. Blue clay, sand, and wood	88– 92
12. Yellowish sand and clay	92– 98
13. White sand, wood, and clay	98–108
Cretaceous:	
14. Gray sand, wood, and clay	108–128
15. Brown sand, wood, and clay	128–138
16. White sand with traces of clay	138–160
17. White sand with wood and clay	160–200

Elevation of surface, 16.0 feet.

279. The following record is taken from a blueprint kindly furnished by Chief Engineer I. M. De Varona:

Record of Brooklyn test well No. 23.

	Feet.
Wisconsin and Tisbury:	
1. Yellow sand	0– 8
2. Gray sand, water bearing	8– 36
3. Coarse gray sand, water bearing	36– 52
4. White sand, gravel, and clay	52– 74
Transition:	
5. Yellow sand, water bearing	74– 78
Cretaceous?:	
6. Clay, sand, and gravel	78–100
7. Clay, sand, gravel, and wood	100–106
8. White sand, clay, and wood	106–130
Cretaceous:	
9. Sand, dark clay, and wood	130–148
10. White sand, clay, and wood	148–168
11. Sand, gravel, wood, and blue clay	168–172
12. Blue clay	172–185
13. Sandstone, iron ore, and wood embedded in black clay	185–198
14. Wood and black clay	198–202
15. Fine white sand, wood, and clay	202–220
16. Sand, wood, and blue clay	220–247
17. Blue clay and iron ore	247–260
18. Sand, wood, and clay	260–276
19. Sand, wood, clay, and iron ore	276–282
20. Sand, clay, and wood	282–296
21. Hard pan; iron	296–298
22. Blue clay	298–312
23. Sand, wood, and clay	312–367
24. Clay with a little sand	367–374
25. Sand, wood, and clay	374–390

Elevation of surface, 16.7 feet.

280. The following record is taken from a blueprint kindly furnished by Chief Engineer I. M. De Varona:

Record of Brooklyn test well No. 22.

	Feet.
Wisconsin and Tisbury:	
1. Yellow sand	0– 15
2. Sharp grayish sand, water bearing	15– 24
3. Coarse, grayish sand, with gravel, water bearing	24– 36
4. Same sand; larger gravel, water bearing	36– 44
5. Fine grayish sand, water bearing	44– 56
6. Gravel, sand, and clay	56– 67
Wisconsin and Tisbury?:	
7. Sharp, yellow sand, water bearing	67– 82
8. Fine grayish sand	82– 90
9. Fine grayish sand with gravel, wood, and clay	90–100
Tisbury and Cretaceous?:	
10. Fine grayish sand with larger gravel, wood, and clay	100–107
Cretaceous:	
11. Gray sand with wood and clay	107–145
12. Gray clay	145–169
13. Clay, wood, and iron pyrites	169–180
14. Sand, gravel, clay, wood, and iron pyrites	180–190
15. Fine grayish sand, clay, and wood	190–220

Cretaceous—Continued.	Feet.
16. Fine sand, clay, wood, and iron pyrites	220–276
17. Sharp grayish sand, clay, and wood	276–310
18. Black muck, wood, and sand	310–324
19. Light-colored gray sand, wood, and traces of clay	324–327
20. White clay, wood, sand, and gravel	327–333
21. Hard pan with white clay	333–343
22. Sharp grayish sand, wood, and traces of clay	343–347
23. Same sand; slightly water bearing	347–356
24. White clay, sand, and wood	356–370

Elevation of surface, 17.4 feet.

281. As no samples were preserved from test well No. 21, the following record is taken from the reports of the inspector:[a]

Record of Brooklyn test well No. 21.

Wisconsin and Tisbury:	Feet.
1. Yellow sand	0– 8
2. Fine yellowish sand	8– 28
3. Fine yellowish sand with a large quantity of mica scales	28– 36
4. Coarser yellowish sand	36– 50
Wisconsin and Tisbury?:	
5. Finer yellowish sand with small gravel	50– 65
6. Fine white sand with large gravel	65– 69
7. Fine white sand with wood and traces of clay	69– 80
Tisbury and Cretaceous?:	
8. Fine brownish sand with wood and traces of clay	80– 85
Cretaceous:	
9. Gray sand with wood and traces of clay	85–116
10. Fine gray sand with wood and traces of clay	116–195
11. Black clay and wood	195–202
12. Gray sand with wood and traces of clay	202–225
13. Gray clay with wood and hardpan	225–236
14. Gray sand with traces of wood and clay	236–240
15. Gray quicksand with traces of wood and clay	240–248
16. Gray clay	248–262
17. Gray sand with traces of wood and clay	262–276
18. Gray sand with wood, clay, and hardpan	276–282
19. Fine gray sand and clay	282–290
20. Sharp grayish sand with traces of wood and clay, slightly water bearing	290–295
21. Sharp grayish sand with wood and traces of clay	295–345
22. Gray sand with wood and traces of clay	345–380
23. Fine white sand with traces of wood and clay	380–410

Elevation of surface 17.8 feet.

282. As no samples were preserved from test well No. 20, the following record is taken from the report of the inspector:[b]

Record of Brooklyn test well No. 20.

Wisconsin and Tisbury:	Feet.
1. Yellow sand	0– 6
2. Yellowish sand	6– 20
3. Yellowish sand with a little gravel	20– 26
4. Fine yellowish sand	26– 36
5. Small light-colored gravel with gray sand	36– 78

[a] Ann. Rept. Dept. City Works of Brooklyn for 1896, 1897, pp. 302–303.
[b] Ibid., p. 301.

	Feet
Cretaceous?:	
6. Fine gray sand with traces of clay	78– 85
7. Gray clay and gravel	85– 90
Cretaceous:	
8. Gray sand with clay and wood	90–100
9. Gray sand with clay, wood, and gravel	100–110
10. Fine gray sand with clay and wood	110–124
11. Fine gray sand with clay, wood, and gravel	124–130
12. Gray sand with clay and wood	130–148
13. Darker gray sharp sand with a little wood	148–152
14. Dark-gray clay with wood and gravel	152–154
15. Light-gray sand with wood and traces of clay	154–172
16. Finer light-gray sand with wood and clay	172–178
17. Fine white sand with wood and clay	178–212
18. Sharp light-gray sand with wood and clay (contains water, but not enough for pumping)	212–225
19. Hardpan and wood	225–228
20. Gray sand with clay and wood (contains water but not enough for pumping)	228–242

Elevation of surface 14.6 feet.

283. *Record of C. Schreiber's well at Valley Stream.*

	Feet.
1. Sand and gravel	0–18

Mr. Baldwin says that the description of this well will apply to all the wells in the vicinity of Valley Stream. In some places it is 2 or 3 feet farther to the water, but there is no change in the material.

284. The Long Island Railroad Company gives the following part analysis of its shallow dug well at this point:

Analysis of railroad well at Valley Stream.

	Parts per million.
Total solids	56.09

285. The following section has been prepared from samples preserved by the Brooklyn water department (see fig. 10):

Record of Brooklyn test well No. 19.

	Feet.
Wisconsin:	
1. Reddish yellow loamy sand	0– 4
Transition:	
2. Fine to coarse light-yellow sand	4– 18
Tisbury:	
3. Light-gray and grayish-yellow sands and gravel, probably glacial	18– 72
Sankaty?:	
4. Yellowish gray clay	72– 95
Cretaceous:	
5. Dark-gray fine to medium sand, with lignite	95–132
6. Black clay with lignite	132–140
7. Grayish-white clay	140–150
8. Medium gray sand with lignite	150–208

"At extreme depth was found to be slightly water bearing; very small flow." Elevation of surface, 9.4 feet, Brooklyn base.

286. The following analysis has been made by the Brooklyn health department:

Analysis of water from wells at Watt's Pond pumping station.

	Parts per million.
Total solids	63.25
Loss on ignition	15.15
Free ammonia	.06
Albuminoid ammonia	.04

	Parts per million.
Chlorine as chlorides	8.87
Sodium chloride	14.62
Nitrogen as nitrates	2.05
Nitrogen as nitrites	None.
Total hardness	16.12
Permanent hardness	16.12

This is the average of 4 analyses.

287. The following section has been taken from a blueprint kindly furnished by Chief Engineer I. M. De Varona; no samples were preserved from this well (see fig. 10):

Record of Brooklyn test well No. 25, at Watt's Pond pumping station.

	Feet.
Wisconsin:	
1. Top soil	0– 3
2. Brown sand and gravel	3– 15
Tisbury:	
3. Yellowish fine sand	15– 62
Transition:	
4. Sand, gravel, and clay	62– 70
Sankaty?:	
5. Clay and gravel	70– 95
6. Fine gray sand; traces of clay and wood	95–118
Jameco?:	
7. Sand and small gravel, water bearing	118–130
Cretaceous:	
8. Black clay, gravel, and wood	130–148
9. Blue clay, gravel, and wood	148–157
10. Sand, wood, and clay	157–160
11. Small gravel, wood, and clay	160–168
12. Sand, wood, and clay	168–176
13. Sand, wood, and clay, water-bearing	176–184
14. Sand, traces of clay and wood	184–220
15. Sharp sand, clay and wood, water-bearing	220–235
16. Fine gray sand, wood, and traces of clay	235–245
17. Sharp, gray sand, clay, and wood, water-bearing	245–284
18. Sand, small gravel, clay, and wood, water-bearing	284–296
19. Whitish clay, sand, and wood	296–302
20. Small gravel, wood, and clay, water-bearing	302–331

Elevation of surface, 8.2 feet.

288. See under No. 290. The following analysis has been made by the Brooklyn health department:

Analysis of water from Clear Stream pumping station.

	Parts per million.
Total solids	64.62
Loss on ignition	16.62
Free ammonia	.01
Albuminoid ammonia	.02
Chlorine as chlorides	7.87
Sodium chloride	12.98
Nitrogen as nitrates	2.51
Nitrogen as nitrites	None.
Total hardness	19.31
Permanent hardness	18.12

This is an average of 8 analyses.

289. The following record has been prepared from samples preserved by the Brooklyn department of water supply (see fig. 10):

Record of well at Clear Stream pumping station.

	Feet.
Wisconsin:	
1. Dark-yellow sandy loam	0– 6
Transition:	
2. Light-yellow medium sand	6– 35
Tisbury:	
3. Darker, yellowish-brown, fine to medium sand	35– 44
4. Fine, light, yellowish-white sand	44– 56
Cretaceous:	
5. Dark-gray fine to coarse sand, with lignite	56– 63
6. Very dark-gray clay (unlike clay above old glacial beds; resembles clay in No. 197)	63– 87
7. Fine to medium gray sands	87–125
8. Gray sand and lignite or peat	125–130
9. Fine to medium gray sand	130–190

Elevation of surface, 13.6 feet. "No water was found in this well."

290. W. D. Andrews & Brother, under date of May 8, 1895, report: "In 1894 we completed for the city of Brooklyn a second contract for two tubular gang-well plants, with a capacity of 5,000,000 gallons each, one plant being located at the Forest Stream and the other at the Clear Stream station. * * * We struck veins of water at these two stations, at and beyond 106 feet in depth, that flowed 10 gallons per minute at the surface from a 2-inch tube, and would rise in a pipe 3 feet above, while the water levels in the auxiliary tubes of the gang wells were several feet below this surface (lowered to that depth by continuous pumping of double the quantity of water required by our contract obligations). Within 60 feet of water veins that would flow 5 to 10 gallons per minute, through 2-inch tubes, from depths of 60, 100, and 300 feet, and yield by hand pumping 30 to 50 gallons from any one of the depths named, we sunk a 4-inch tube 400 feet, and the only water found was at about 35 feet, which did not rise above the level at which it was first encountered, nor yield, by hand pumping, above 5 gallons per minute.

Phillips & Worthington report the following section of a test well at this point (see fig. 10):

Record of test well at Forest Stream pumping station.

	Feet.
Wisconsin and Tisbury:	
1. Stratified clays and sands, with underlying strata containing water	0–100
Jameco[a]:	
2. Water-bearing iron formation	105–115
Cretaceous:	
3. Hard white sticky clay	115–260
4. Various stratified sands	260–435

It is quite probable that the water-bearing formation from 105 to 115 is Jameco. The "hard white sticky clay" is probably the same as the fine white or gray lignitiferous sands found in the Brooklyn waterworks test wells.

Mr. De Varona reports that the water from the deep test well at Forest Stream station is so impregnated with sulphureted hydrogen as to be unfit for use."

The following analysis has been made by the Brooklyn health department:

Analysis of water from Forest Stream pumping station.

	Parts per million.
Total solids	52.87
Loss on ignition	12.00
Free ammonia	.02
Albuminoid ammonia	.02
Chlorine as chlorides	7.69

[a] History and Description of the Brooklyn Waterworks, 1896, p. 16.

	Parts per million.
Sodium chloride	12.67
Nitrogen as nitrates	.66
Nitrogen as nitrites	None.
Total hardness	21.94
Permanent hardness	19.44

This is the average of 8 analyses.

291. The following record has been prepared from the samples preserved by the Brooklyn water department (see figs. 10, 13):

Record of Brooklyn test well No. 12.

	Feet.
Wisconsin:	
1. Yellowish surface loam	0 – 5
2. Fine to coarse light yellowish brown speckled sands	5 – 30
Tisbury:	
3. Medium to coarse light yellowish, white sand	30 – 46
4. Medium yellow sand with quartz pebbles below	46 – 63
5. Yellowish gray clay with quartz pebbles	63 – 66
6. Medium light-yellow sand	66 – 73
7. Light, reddish yellow, medium sands	73 – 98
Sankaty:	
8. Fine gray silt	98 – 98.5
Jameco:	
9. Dark, multicolored, dirty sands (old glacial)	98.5–138
Transition:	
10. Transition	138 –145
Cretaceous:	
11. Fine gray sands	145 –162
12. Fine, dark-gray, clayey silt	162 –172
13. Gray sand with occasional quartz pebbles and pieces of lignitized wood. Wood very abundant at 340 feet	172 –406

Elevation of surface 18 feet. "No water was found in the strata below the clay bed."

292. The following record has been prepared from the samples preserved in the municipal building, Brooklyn (see fig. 10):

Record of Brooklyn test well No. 13.

	Feet.
Wisconsin:	
1. Surface yellow loam	0– 8
2. Fine to medium reddish-yellow sands	8– 32
Transition:	
3. Medium yellow sand, speckled with black	32– 58
Tisbury:	
4. Yellowish-white sand and gravel. No glacial pebbles	58– 70
Jameco:	
5. Fine, reddish yellow, silty sand becoming coarser below, and containing good sized pebbles; many erratics	70–102
Cretaceous:	
6. Gray clay	102–105
7. Very dark clay, lignite, and pebbles	105–112
8. Fine gray sand with lignite	112–122
9. Gray clay	122–130
10. Fine dark-gray sand	130–175
11. Very coarse gray sand and small pebbles	175–190
12. Fine dark-gray sand with occasional quartz pebbles and lignite	190–412

Elevation 21.5 feet, Brooklyn base.

The presence of reddish yellow silty sand containing a considerable percentage of the compound pebbles which ordinarily characterize the glacial deposits, and which is here not separated by a clay bed from the overlying yellow sands with no glacial material, is unique in this section and doubtless represents a Jameco deposit, which has either never been covered by Sankaty clay or from which the clay has been removed by erosion.

293. The following section has been prepared from the samples preserved by the Brooklyn water department (see fig. 10):

Record of Brooklyn test well No. 14.

	Feet.
Wisconsin:	
1. Surface loam	0– 6
Transition:	
2. Medium light-yellow speckled sand	6– 50
Tisbury:	
3. Fine to light-yellow sand	50– 55
4. Fine to coarse grayish white sand	55– 58
Cretaceous:	
5. Very light-yellow silt, looks like loess	58– 62
6. Fine sand to coarse gravel, with many pieces of ferruginous concretion	62– 72
7. Light-yellow sand	72– 77
8. Yellowish white sand and gravel	77– 92
9. Fine dark-gray sand	92–125
10. Very fine dark-gray sand	125–135
11. Grayish white fine to medium sands, with lignite at 181 and at 244 feet	135–328
12. Very fine gray silty clay	328–342
13. Fine gray sand	342–350
14. Very fine gray sand	350–365
15. Fine to medium gray sand	365–390

Elevation of surface, 16.7 feet. "No water found in this well."

294. *Record of commission's well near Rosedale.*

	Feet.
Wisconsin:	
1–2. Surface loam	0– 1
3–9. Reddish-yellow outwash gravel	5–30.5

See Table XII.

295. The following section has been prepared from the samples preserved by the Brooklyn water department:

Record of Brooklyn test well No. 10, near Springfield.

	Feet.
Wisconsin:	
1. Yellow surface loam	0– 2
2. Fine to coarse yellow sands and gravel (glacial)	2– 40
Tisbury:	
3. Medium bright-yellow sands, probably glacial	40– 54
4. Fine and coarse yellowish gray sands	54– 73
5. Orange sand and gravel	73– 80
Transition:	
6. Gray sand with much lignite	80– 89
Sankaty(?):	
7. Blue-gray clay	89– 94
Cretaceous:	
8. Fine white sand	94–102
9. Fine gray sands with lignitized wood, well marked at 110–112, 139, 177–180, 199–200, 219, 229, 235, 241–242, 250–252, 295, 306 feet	102–357

All trace of glacial material ceases at 54 feet, and in the examination of samples this point was selected for the line between the Pleistocene and pre-Pleistocene deposits. The yellow gravels, however, suggest the Far Rockaway material, and the blue-gray clay the Sankaty. Elevation of surface, 27 feet. "No water was found in the strata below the blue clay bed."

296. *Record of commission's test well near Fosters Meadows.*

	Feet.
Wisconsin and Tisbury?	
1–2. Surface loam	0– 1
3–10. Reddish-brown outwash sand, with very little gravel	5–35.5

See Table XII.

297. *Record of commission's test well 1 mile north of Valley Stream.*

	Feet.
Recent?	
1–2. Surface loam	0 – 1
3–4. Black sand; considerable percentage of MnO_2 (swamp deposit)	2.5– 5.5
Wisconsin and Tisbury:	
5–8. Light yellow sand	9.5–26

There is very little glacial material in the two lower samples.

298. *Record of commission's test well 2 miles north of Valley Stream.*

	Feet.
Wisconsin:	
1–2. Yellow surface loam	0– 1
3–6. Outwash sand, reddish brown	5–21
Tisbury?	
7. Light-yellow sand (nothing recognizably glacial)	25–25.5

299. *Record of commission's test well between Valley Stream and Floral Park.*

	Feet.
Wisconsin:	
1–2. Surface loam	0 – 7
3–9. Reddish brown silty sand and gravel (considerable glacial material)	6 – 36
Tisbury:	
10–16. Lighter, brownish yellow, medium sand, doubtfully glacial; no sharp line can be drawn between this material and that either above or below	42 – 73
Cretaceous:	
17–18. Fine to coarse white sand	76 – 82
19–21. White sand and gravel (not recognizably glacial)	84 – 96
22–23. Yellowish white sand with a little clay	96.5– 98.5
24. Light gray sand and gravel	99.5–100.5
25. Very fine, dark-yellow, clayey sand	101.7–102
26. Very fine, light grayish white sand, with much silvery white muscovite	105.5–106.5
28. Very light, grayish yellow, clayey sand	106.6–107.1
29. Very fine white sand with muscovite and a little lignite	107.5–108
30. Very fine clayey sand with lignite and muscovite, yellowish brown	108 –109
31. Fine grayish sand with muscovite and lignite	110 –111
32. Very fine brownish white sand	112.5–113.5
33. Very dark grayishs and, with muscovite	114.7–115.5
34. Black sandy clay with lignite	115.5–116.5
35. Very black sandy clay, with FeS	120 –120.5

300. *Record of commission's test well 2 miles southeast of Queens.*

	Feet.
Wisconsin and Tisbury?:	
1–12. Reddish-yellow glacial sands and gravel, with much biotite	0–41

301. *Record of commission's test well 1 mile south of Queens.*

	Feet.
Wisconsin and Tisbury?:	
1. Dark sandy loam.	
2. Subsoil sandy loam.	
3. Medium yellow sand	5– 5.5
4. Sand with fine gravel; considerable erratic material	10–11
5. Wash sample shows fine grayish sand, while the sand-bucket sample shows a large percentage of gravel	15–15.5
6. Grayish-yellow sand (sand-bucket and wash samples very nearly the same)	20–21
7. Same, except that sand-bucket sample shows some gravel	25–25.5

302. A number of shallow wells were put down at this point by the commission on additional water supply for pollution tests, by Mr. George Whipple, of the Mount Prospect laboratory. The material penetrated was entirely glacial outwash sand and gravel.

303. *Record of commission's test well near Floral Park.*

Wisconsin and Tisbury:	Feet
1. Surface, dark sandy loam	0–
2. Lighter loamy sand, some gravel	– 5
3. Coarse yellow sand	5– 5.5
4. Medium grayish-yellow sand with some small gravel	10–10.5
5. Same, with more gravel	15–16
6–7. Fine grayish yellow sand	20–26
8. Grayish yellow sand with considerable gravel	30–30.5
9. Reddish yellow sand	35–36
10. Same, but with more gravel	40–41

The whole section is apparently outwash gravel. See Tables XII and XIII.

304. *Record of commission's test well, 2 miles south of New Hyde Park.*

Wisconsin and Tisbury?:	Feet.
1–2. Yellow loamy sand	1– 3
3. Yellow sand, some clay	6
4. Coarse grayish yellow sand	10–11
5–6. Reddish yellow sand	12–15
7–8. Coarse yellow sand to fine gravel, with some erratics	19–25
9–10. Grayish yellow sand, with much biotite	29–36
11. Coarse grayish yellow sand	38

305. *Record of commission's test well near New Hyde Park.*

Wisconsin:	Feet.
1. Black sandy loam	0– 5
2. Reddish yellow clayey sand	4
3. Reddish yellow sandy clay	8– 9
4. Reddish brown very fine to coarse sand, with much mica and erratics	14–15
5. Gravel up to three-eighths inch in diameter; some erratics	19.5
Tisbury:	
6–7. Reddish yellow fine to coarse sand	21–26
8–9. Fine sand	28–32.5

306. *Record of commission's test well near New Hyde Park.*

Wisconsin:	Feet.
1–2. Surface loam and sand	0– 1
3–9. Reddish-brown outwash sand and gravel	5–36
Tisbury:	
10–13. Fine to coarse grayish sand, clearly glacial, but differing in appearance from that just above it	36–56

307. *Record of commission's test well near New Hyde Park.*

Wisconsin:	Feet.
1–2. Surface, loamy sand	0– 1
3–5. Light reddish yellow outwash sand and gravel	5–16
5½. Dark-gray outwash sand and gravel	17–17.3
6–7. Reddish brown silt to coarse sand (glacial outwash)	20–26
8–9. Fine to coarse grayish sand (glacial)	30–38
10. Very fine light-grayish sand and clay	43–43.5
Transition:	
11–16. Grayish brown outwash sand and gravel	45–71
Tisbury:	
17. Coarse light-yellow sand, with a much smaller percentage of glacial material than in samples above	73–74

308. *Record of commission's test well near New Hyde Park.*

	Feet.
Wisconsin:	
1–2. Surface loam	0– 1
3–17. Dark-gray outwash sand and gravel; very large percentage of erratic material	2. 5–66. 5

See Tables XII, XIII.

310. *Record of commission's test well near Floral Park.*

	Feet.
Wisconsin:	
1–2. Dark gravelly loam	0 – 1. 5
3–8. Grayish brown outwash sand and gravel	4 – 31
Tisbury:	
9–12. Medium to fine gray sand	35 – 53
13. Medium gray sand, with small gravel	55 – 56
14–17. Fine grayish-brown gravel, with some sand; contains some erratic material	60 – 77
Cretaceous:	
18. Very fine yellow sand	80. 5– 81. 5
19–23. Light yellow, medium, quartz sand lacking the erratic particles in the upper samples	84 –106
24–26. Very fine, yellow, silty sand	109 –117
27. Dark sandy clay	120 –121
28. Very fine dark-gray sand	130 –134
29. Very fine, dirty yellow sand	148 –149

Sample No. 25 was obtained when the small hand pump was changed to a larger force pump. It consists of coarse, varigated gravel with many glacial pebbles, and represents the accumulated coarser material from the upper part of the well. It does not represent material from the depth, 113 feet, from which it was obtained. See Tables XII, XIII.

312. *Record of commission's test well near Creedmoor.*

	Feet.
1–18. Outwash sands and gravel	0–73

See Table XII.

315. See fig. 35 and Pl. XIV.

316. J. H. Herbert reports the following section for this well:

Record of Jagnow Brothers' well near Douglaston.

	Feet.
Wisconsin and Tisbury:	
1. Yellow clay and sand	0– 35
2. Yellow sand and small bowlders	35– 47
3. Coarse yellow sand and gravel	47– 55
4. Coarse brown sand and iron gravel	55– 67
5. Fine brown sand	67– 71
6. Fine yellow sand	71– 77
7. White beach sand	77– 89
8. White and yellow sandy clay	89–107
9. Coarse yellow sand and gravel	107–127

317. The well at this place was started by Stotthoff Brothers, who furnished the following samples:

Record of well of W. K. Vanderbilt, jr., near Lake Success.

	Feet.
1. No record	0– 40
Wisconsin, Tisbury, and Mannetto:	
2. Fine sand to large gravel, with a large percentage of erratic material	40–125
3. Reddish-yellow medium sand, with small gravel (contains glacial material)	125–145
Cretaceous:	
4. Yellow medium sand (not glacial)	145–191

The water in this well stood 116 feet from the surface and tested 21 gallons per minute for twenty-four hours, when the test was pushed up to 40 gallons per minute. The elevation of the ground is 171 feet as determined by the engineers of the commission on additional water supply. The screen was placed from 166 to 186 feet. Later this well was deepened by Thomas B. Harper, of Jenkinstown, Pa. The following record has been transmitted to the Survey by Mr. Alexander S. Farmer:

Record of well of W. K. Vanderbilt, jr., near Lake Success.

	Feet.
Pleistocene:	
1. Earth and clay	10– 80
2. Yellow sand	80–100
Transition:	
3. Yellow sand and gravel, water bearing	100–200
Cretaceous:	
4. Hard crisp sand or cemented sand	200–425
5. Sand and clay in layers; light-colored clay and yellowish-white sand	425–460
6. Organic matter—wood; becomes black after exposure	460–538
7. Red clay	560–660
8. Fine yellowish-white sand; Lloyd sand	660–700
9. White and coarse gravel; free water-bearing strata; Lloyd sand	700–750
10. Blue clay; becomes light colored upon exposure	750–755

318. *Record of commission's test well near Lake Success.*

	Feet.
Wisconsin:	
1–2. Yellow sandy loam	0– 3
3–8. Dark-grayish glacial sand	8–35

See Table XII.

319. According to Mr. E. Lewis, oyster and clam shells were taken from the sands beneath the bowlder drift at Lakeville at a depth of 140 feet.[a]

320. *Record of commission's test well between New Hyde Park and Lake Success.*

	Feet.
Wisconsin and Tisbury?:	
1. Dark sandy loam	0– 0.4
2. Yellow loamy sand	0.4– 1.5
3. Black sandy loam	1.5– 4.4
4–6. Yellowish-brown outwash sand and gravel	4.4–24
7–9. Very fine, yellow to gray, silty sand	24 –36
10. Yellow sand to fine gravel containing many erratics	39.5–40
11. Medium gray sand	41 –42
12. Fine gravel with many erratics	43 –45

321. *Record of E. C. Willetts's well near Plattsdale.*

	Feet.
Wisconsin:	
1. Loam	0– 4
2. Red clay and stones	4–36
3. Hardpan; very hard substance containing many angular stones cemented together with iron	36–37
4. Very fine white sand containing dark-colored mica; water bearing	37–

In spring the water comes up to within a few feet of the surface; in the dry season it is within 21 or 22 feet of the surface: evidently a perched water table.

322. *Record of A. Kiefer's well near Plattsdale.*

	Feet.
Wisconsin:	
1. Very hard marl with some cobbles	0 – 80
Cretaceous:	
2. Yellow sand	80 –114
3. Clay	114 –114.5
4. Water-bearing sand	114.5–116

[a] Pop. Sci. Monthly, vol. 10, 1877, p. 442.

323. *Record of commission's test well 1 mile south of Manhasset.*

	Feet.
Wisconsin and Tisbury?:	
1–2. Sandy loam	0– 1.5
3. Dark-brown silty sand	1– 5
4–9. Sand and gravel (glacial)	9–35
10–11. Brownish-yellow silty sand (apparently glacial)	39–47

See Tables XII, XIII.

324. *Record of W. J. Hamilton's well near Little Neck.*

	Feet.
Wisconsin? and Tisbury:	
1. Fine yellow sand	0– 45
2. Coarse yellow sand	45– 55
3. White beach sand	55– 63
Cretaceous?:	
4. White coarse sand and small gravel	63– 71
5. White fine sand and yellow fine gravel	71– 83
Cretaceous:	
6. White, fine, beach sand	83– 99
7. White, coarse, beach sand	99–102
8. Blue clay	102–125
9. White coarse sand	125–143
10. White small gravel	143–147

325. Same section as 324.

326. *Record of commission's test well near Thomaston.*

	Feet.
Wisconsin:	
1–3. Yellow sandy clay	0 – 4
4–5. Dark, multicolored, fine sand to coarse gravel, pronouncedly glacial	8 –12
6–8. Yellowish-brown clayey silt with gravel	16 –27
Tisbury:	
9–12. Fine to coarse glacial sand and gravel	32 –41.5
Cretaceous:	
13. Light-yellow, highly micaceous, clayey sand	42.7–43.5
14–17. White, clayey; highly micaceous sand	44.5–60.5
18. Fine, pinkish white, micaceous sand	64.5–65.5
19. Fine, light-yellow, clayey sand	69.5–70.5
20. Fine to coarse yellow sand	75 –76
21. Medium to coarse white sand; water bearing	78 –79

327. *Record of J. B. Hixon's well near Thomaston.*

	Feet.
Wisconsin:	
1. Yellow clay	0–26
Transition:	
2. Yellow fine sand	26–44
Tisbury:	
3. Coarse, brown, iron-stained gravel	44–52
4. Brown sand and clay	52–56
Cretaceous:	
5. White and pinkish clay	56–61
6. White fine beach sand	61–77
7. Yellow fine beach sand	77–83
8. Yellow clay and sand	83–85
9. Yellow coarse sand	85–93

329. Phillips & Worthington report the following section:

Record of railroad well at Great Neck station, Thomaston.

	Feet.
Tisbury:	
1. Sand	0–90
Cretaceous:	
2. Blue clay	90–93
3. Water-bearing strata of sand	93–100
4. Gravel	100–112

330. *Record of commission's test well near Manhasset.*

	Feet.
Wisconsin:	
1–3. Dark, brownish-yellow, clayey sand	0–5
Cretaceous?:	
4–7. Fine, dark-gray or bluish-gray silty sand	9–25

332. Water rises to a height of 13 feet above the surface, which is perhaps 5 feet above extreme high tide.

Mr. Hamilton reports that the only change ever noticed in this well was during the earthquake that occurred in September, 1898. Then the well commenced to flow very strongly and continued to do so for eight or ten hours, when it became normal and has remained so ever since.

Record of J. F. Hamilton's well at Manhasset.

	Feet.
1. Gravel and ironstone	0–10
2. Quicksand	10–70
3. Iron ore	70–70.6
4. Quicksand	70.6–74
5. Iron ore	74–75
6. Quicksand, with artesian water	75–78
7. Iron ore	78–

335. Fig. 33 illustrates a typical case of a flowing well having many of the aspects of a spring. In this case the pipe was driven to a depth of 10 feet and flowing water obtained, as illustrated. It also shows the difference in flow at high and low tide, which is common in nearly all of the wells along the shore and the mud springs or mud cones on the bottom of the bay; these latter are evidently the same as the cones which were studied near Douglaston.

337. *Record of commission's test well near Manhasset Hill.*

	Feet.
Wisconsin and Tisbury?:	
1–3. Dark, bowldery, surface loam	0–5
4–10. Reddish brown glacial sand and gravel, with large percentage of erratic material.	11–28

338. *Record of H. Lustgarten's well near Manhasset Hill.*

	Feet.
Wisconsin:	
1. Loam	0–3
2. Hard pan	3–4
Transition:	
3. Light-colored sand and gravel	7–85
Tisbury:	
4. Quicksand and gravel	85–127

340. *Record of commission's test well near Manhasset Hill.*

	Feet.
Wisconsin:	
1–3. Brownish yellow silty sand	0–5
4–11. Dark fine sand and small gravel, containing much glacial débris	9–45
Cretaceous:	
12–19. Fine white, micaceous, clayey sand	48–87.5

341. *Record of Great Neck School well at Great Neck.*

	Feet.
Tisbury:	
1. Surface sand and gravel	0–26
Cretaceous?	
2. Clay	26–52

Mr. Kasteard left this well one night without having encountered water; when he came back the next morning there was 9 feet of water in the well, and the water gradually rose until it came within 30 feet of the surface; it is probable that he had gotten down very near the bottom of the clay layer and that during the night the water worked its way through.

342. *Record of Mrs. M. G. King's well near Great Neck.*

	Feet.
Wisconsin:	
1. Red clayey loam	0–4
2. White medium sand	4–6
3. Hard pan	6–12
Tisbury:	
4. White sand with occasional streaks of iron	12–22
5. White sand, described as good building sand	22–45
6. Sand with cobbles	45–48
7. Ordinary sand	48–52

344. *Record of H. B. Booth's well, Great Neck.*

	Feet.
Pleistocene:	
1. Sand and gravel	0–6
Cretaceous:	
2. Clay of various colors; some dark, some light, some reddish	6–240
3. Water-bearing sand (Lloyd sand)	240–

345. The following section should probably be regarded as only approximate:

Record of H. B. Anderson's well, Great Neck.

	Feet.
Pleistocene:	
1. Hard clay and gravel; some bowlders	0–50
Cretaceous:	
2. Quicksand and very fine white sand	50–237

347. *Record of Wm. R. Grace's well, Great Neck.*

	Feet.
1. Various sands	0–103
2. Hard pan	103–104

348. *Record of V. P. Travis's well, Great Neck.*

	Feet.
1. Sand and gravel	0–
2. Hard yellow clay.	
3. Yellow water-bearing gravel	–119

Surface water was encountered at 24 feet; the water from the lower horizon stands 77 feet from the surface.

350. Mr. Herbert has kindly furnished the following samples from this well:

Record of Robert Cox's well, Great Neck.

	Feet.
Tisbury:	
1. Clean glacial gravel	0–6
Cretaceous:	
2. Coarse white sand and small gravel	8–9
3. White sand	11
4. Fine yellowish white sand	21
5. Fine white sand	35
6. Very fine white sand	52

351. Mr. Isaac Kasteard, who dug the upper part of this well, reports the following section:

Record of Robt. Seizer's well near Plandome Mills.

	Feet.
Wisconsin:	
1. Water-bearing sand	0–17
2. Fine sand	17–21
3. Clay and quicksand (containing mica)	21–

Mr. George Schmidt, who completed this well, gives the following data:

Record of Robt. Seizer's well near Plandome Mills.

	Feet.
Wisconsin:	
1. Dug well	0–21
Tisbury?:	
2. Sand	21–50
Sankaty?:	
3. Bay mud and sand	50–100
Jameco?:	
4. Coarse sand with no clay	100–113

352. *Record of Charles Vanderbilt's well near Port Washington.*

	Feet.
Wisconsin and Tisbury:	
1. Surface loam	0–8
2. Gravel and cobbly sand	8–80
3. Coarse sand	80–

354. *Record of commission's test well near Port Washington.*

	Feet
Wisconsin:	
1–3. Fine, yellowish-brown, silty sand	0 – 5
Transition:	
3–6. Dark yellowish brown sand and gravel of glacial origin	9 –25
Tisbury:	
7. Very fine, brown, micaceous, silty sand	27 –28
8. Very fine, yellow-white, silty sand	31. 5–32. 5
9–10. Fine, dark-brown, micaceous sand	36. 5–40
11. Dark-gray micaceous sand to small gravel; looks like glacial rock débris	45 –46
12. Very fine, brown, silty sand	49. 5–50. 5
13. Yellowish brown sand with small gravel (glacial material)	54 –55
Cretaceous?:	
14–16. Very fine reddish-brown to steel-gray, silty, micaceous sand	59 –70
17–18. Dark, steel-gray, very fine, clayey silt (blue clay)	74 –79
19–20. Dark, grayish-brown, micaceous, silty sand	82. 5–87

357. *Record of T. Valentine's well near Port Washington.*

	Feet.
Wisconsin:	
1. Hardpan and dark iron soil, very hard	0– 15
Transition:	
2. Cobbles	15– 33
Tisbury:	
3. Yellow sand	33– 53
Manhasset bowlder bed:	
4. A very compact layer of stones, which appeared to be put in almost artificially	53– 60
Tisbury:	
5. White sand, described as good building sand	60– 80
Tisbury?:	
6. Yellow sand	80–123
7. White gravel	123–129

358. *Record of N. H. Jacobs's well near Port Washington.*

	Feet.
1. Dug well	0–24
2. Yellow sand and gravel	24–32
3. Clay, between blue and white in color	32–35
4. Sand and gravel; water-bearing	35–

360. Mr. George Schmidt reports the following section:

Record of T. E. Webb's well near Port Washington.

	Feet.
1. Loam, gravel, and sand	0– 68
2. Clay	68–200
3. Sand and gravel, water-bearing	200–205.6

At 207 feet carbonized wood was found. Top of well is 73 feet above high water.

Mr. John Fischer, who drilled the first 145 feet of this well, reports that water was found in soft, clayey sand, and that the greater part of the well was in soft clay or clayey sand; at 140 feet a lignitized log was struck.

361. *Record of Isaac Kasteard's well near Port Washington, N. Y.*

	Feet.
1. Surface loam; no stones	0–10
2. Cobbles and iron ore (size of cobbles, 4 to 8 inches in diameter)	10–18
3. Varicolored sands, each stratum about 4 feet thick (described as good building sand)	18–69

362. The Long Island Railroad Company have furnished the following partial analysis from their 60 to 70 foot driven well:

Analysis of railroad well near Port Washington.

	Parts per million.
Total solids	74.72
Chlorine	12.82

363. *Record of F. Vanoski's well near Port Washington.*

	Feet.
1. Hardpan—clay and bowlders	0– 6
2. Varicolored coarse sand, containing occasional streaks of iron	6–46

364. *Record of Charles H. Mason's well near Port Washington.*

	Feet.
1. Fine brown sand	0–18
2. Black marl containing oyster shells	18–38
3. Clayey loam	38–42
4. "Black marl" with pebbles	42–52
5. Very fine sand with iron; water-bearing	52–79
6. White sand and gravel mixed	79–83

A shell from stratum No. 2 has been identified by Dr. W. H. Dall as *Ostrea virginica* and is regarded as probably Pleistocene.

365. *Record of Catholic Church well near Port Washington.*

	Feet.
1. Loam and gravel	0– 4
2. Coarse white sand	4–52
3. Very fine sand	52–54

366. *Record of well of Dodge estate near Port Washington.*

	Feet.
Wisconsin:	
1. Yellow stony loam	0– 6
Tisbury:	
2. Fine dry sand	6–16

Manhasset bowlder bed?:	Feet.
3. Rough stratum of cobbles with scarcely any sand between	16–22
Tisbury:	
4. White building sand; very compact	22–40
5. White loose dry sand	40–50
Sankaty or Cretaceous:	
6. Yellow dry clay	50–71
7. Blue clay, containing some water	71–91

The pipe broke off at the last depth given and the clay was not penetrated.

368. *Record of G. Zabriskie's well near Sands Point.*

	Feet.
1. Fine white beach sand	0– 80
2. Blue clay (like putty when wet, impalpable when dry)	80–120
3. Pure white sand; whiter than that in stratum 1	120–250

In the sand at 120 feet lignite, clam shells, and oyster shells were found. At 250 feet a hard substance was encountered upon which drilling made no impression; Mr. Schmidt then abandoned the job, and Mr. A. J. Connolly attempted to drill farther; after working three weeks, he also abandoned the well. Mr. Schmidt says that none of the hard material was brought to the surface. This probably represents bed rock.

369. *Record of well at Castle Gould, near Port Washington.*

Wisconsin:	Feet.
1. Surface loam	0– 3
2. Black hardpan (rough, stony material, with no clay)	3–26
Tisbury:	
3. Coarse gravel	26–30
4. Sand	30–40
5. Fine sand containing mica	40–42
6. Coarse sand (described as good building sand)	42–88

370. Mr. C. H. Danis reports that he put down a test well at this point to a depth of about 300 feet; the material passed through was successive small layers of sand and clay, none exceeding 4 to 6 inches in depth. At last a thick bed of gravel was reached, when the pipe broke: the water in the well rose to a point 12 feet above mean high tide: it would, therefore, have been a flowing well on the beach.

371. *Record of well at Castle Gould, near Port Washington.*

Wisconsin and Tisbury:	Feet.
1. Coarse gravel, with very little water	6– 51
Tisbury and Cretaceous:	
2. White sand	51–109
Cretaceous:	
3. Gray clay	109–119
4. Fine sand	119–127
5. Sandy clay	127–152
6. Quicksand	152–158
7. Blue clay	158–161
8. Water-bearing sand	161–166
9. Fine sand	166–169
10. Quicksand	169–

"We placed a Cook patent strainer between 161 and 166 feet, and although at the first test the well only showed 2½ gallons per minute, we were able, after developing the well, to get over 30 gallons per minute. Lower down the hill, at a difference in elevation of about 40 feet, where we had 10 feet of this coarser water-bearing sand, we obtained 102 gallons per minute." —*J. D. Kilpatrick.*

372. Mr. Danis reports the material penetrated in this well as all white sand. This well flows at times, and would flow continually if the sand were coarser, the stoppage of the flow apparently being due to clogging with fine sand. The elevation is about 15 feet above mean high tide.

373. The following section to a depth of 158 feet has been prepared from samples furnished by Mr. Paul K. Ames, of the Long Beach Association; the remainder is from the record of the driller, Mr. W. C. Jaegle:

Record of well of Long Beach Association at Long Beach.

	Feet.
Recent:	
1. White beach sand, with water-worn fragments of shells	0– 36
2. Dirty gray sand, with small quartz pebbles and particles of vegetable matter	36– 40
Tisbury:	
3. Fine to coarse gray sand, with a few small quartz pebbles (salt water)	40– 50
4. Medium gray sand; no gravel	51– 55
5. Grayish yellow sand and small gravel, with a few greensand grains	55– 65
6. Yellowish gray sand	65– 70
7. Orange-yellow sand and gravel, similar to Rockaway material	70– 73
Sankaty:	
8. Gray sand and gravel, similar to No. 7 in texture, but not iron-stained	73– 76
9. Large quartz gravel and pieces of blue clay containing sand and gravel	76– 82
Jameco:	
10. Dark, multicolored coarse sand and gravel; considerable percentage of flattened shale pebbles; only 50 to 60 per cent of quartz; some biotite; looks as if it might be a sample taken from the Wisconsin moraine in the center of island	82– 90
Cretaceous:	
11. Black sand composed of fine, gray, quartz sand with a large percentage of lignite; some FeS and S; several large pieces of lignitized wood at 99 feet	90– 99
12. Grayish sand with some free sulphur and a few particles of lignite	99–107
13. White sand with occasional patches tinged lemon yellow, perhaps due to iron stains; a few particles of free sulphur	107–111
14. Dark-gray silty sand	111–119
15. White sand with small pieces of lignite; note on bottle says "120, petrified wood"	119–121
16. Very dark colored clay ("blue clay")	121–135
17. Coarse, gray, clayey sand, with particles of sulphur	135–143
18. Medium dark-gray sand (salt water)	143–145
19. Very coarse dark-gray sand	145–156
20. Olive-green sand and small quartz gravel; some sulphur salt water)	156–158
21. Very dark lead-colored clay	158–174
22. White sand, containing at 190 a log of lignitized wood	174–192
23. White gravel and salt water	192–196
24. Clay	196–200
25. Fine sand	200–220
26. Solid blue clay	220–270
(At 270 fresh water, sweet and chalybeate.)	
27. White sand and wood	270–276
28. Clay	276–282
29. White sand and wood	282–297
30. Blue clay	297–305
31. White sand, wood, and water	305–308
32. Blue clay	308–317
33. White sand containing wood and artesian water	317–325
34. Blue clay	325–340
35. White sand and mineral water; has considerable CO_2, sparkling and effervescent	340–356
36. Blue clay	356–360
37. White sand and pure water	364–378
38. Blue clay	378–380
39. White sand	380–381
40. White clay	381–383
41. Fine sand with artesian water	383–386

On May 6, 1903, well was flowing 5 gallons per minute, at a height of about 1 foot above the surface of the ground; it was from this well that the tide curve shown in fig. 34, was obtained.

The water from a depth of 270 feet has been analyzed by Endermann and Saarbach, analytical chemists of New York, with the following results:

Analysis of water from depth of 270 feet in Long Beach Association's well at Long Beach.

	Parts per million.
Alkali	125.000
Lime	3.525
Magnesia	4.276
Oxide of iron	7.057
Chlorine	158.750
Sulphuric acid	14.760
Silica	3.577
Total	317.545

Analysis of water from 383 to 386 feet by Doctors Endermann and Saarbach:

Analysis of water from depth of 383–386 feet in well of Long Beach Association at Long Beach.

	Parts per million.
Total residue	157.32
Organic and volatile matter	54.72
Mineral residue	102.6
Free ammonia	.07
Albuminoid ammonia	.13
Nitrous acid	None.
Nitric acid	1.71
Oxygen required for organic matter	4.79
Chlorine	29.07

374. The following section has been prepared from samples preserved in the museum of the Long Island Historical Society:

Record of well at Hempstead poorhouse, Barnum Island, New York.

	Feet.
Tisbury:	
1. Orange sand and gravel	0– 4
2. Fine yellowish brown sand	5
4. Orange sand and gravel	15
5. Very, dark-gray, clayey sand, with a few quartz pebbles	22
6. Small and medium quartz pebbles orange yellow	29
7. Fine to coarse orange-yellow sand	40
8. Same	60
9. Yellow clay and gravel, partly cemented with iron	63
10. Fine yellow sand	70
Transition:	
11. Fine to medium dark-gray sand	74
Sankaty:	
12. Very fine dark-gray clay, with a little lignitized wood	75
13. Dark-gray clay	95
14. Same	113
15. Dark-gray clayey sand and gravel	126
Jamecot:	
16. Gravel of quartz and chert; has no recognizable erratics, but colors suggest glacial material; quite different from the orange sand at the top of the section	129

Cretaceous:	Feet.
17. Dark-gray sand	135
18. White micaceous sand	147
19. White sand and orange gravel; a few fragments of red quartzite	168
20. Coarse gray sand	170
21. Fine to coarse dirty yellowish gray sand	175
22. Coarse white sand with lignite	180
23. Lignite	200
24. Very fine gray clayey sand	225
25. Coarse grayish white sand	243
26. Much lignite in gray sand	245–270
27. Gray sand and lignite	270–370
28. Gray clay	380
29. Carbonaceous clay	383

These samples were furnished by the driller, Mr. Theodore A. Carmen, who gave the following data regarding this well in a letter dated April 24, 1895:

"Some years ago I attempted to bore a well near the shore; at 123 feet reached fresh water; we continued boring to a depth of 380 feet; the soil was fine beach sand and clay, but the water was not good and did not rise to the surface."

A record of the well has been published by Lewis,[a] who adds the following remarks on the section:

"The deposit of clay between 70 and 126 feet seems closely analogous to many clays now found upon, and at various depths beneath, the surface of the island; it is evidently a local deposit, such as might occur in the depressions of the surface. Two tube wells have been driven at no great distance from Barnums Island, one 97 and the other 194 feet, in which no similar layer of clay was detected." Other records have been published by Merrill,[b] Darton,[c] and Woolman.[d]

375. As the artesian water obtained from the deep well at Long Beach, No. 373, was so chalybeate that it was undesirable for domestic use, a pumping plant was established at East Rockaway which draws its water from shallow wells in the surface gravels.

The following analysis by Doctors Endermann and Saarbach has been furnished by Mr. Paul K. Ames:

Analysis of water from pumping plant of Long Beach Association near East Rockaway.

	Parts per million.
Total residue	94.05
Organic and volatile matter	13.68
Mineral residue	80.37
Free ammonia	Trace.
Albuminoid ammonia	Trace.
Nitrous acid	None.
Nitric acid	2.82
Oxygen required for organic matter	56.94
Chlorine	19.32

375A. *Record of J. H. Clark's well at East Rockaway.*

Tisbury:	Feet.
1. Sand	0– 6
2. Coarse white gravel	6– 8
3. Sand	8–21
4. Coarse white gravel	21–24
Tisbury?:	
5. Bright-yellow clay which tasted like alum	24–27

[a] Pop. Sci. Monthly, vol. 10, 1877, p. 442.
[b] Annals N. Y. Acad. Sci., vol. 3, 1886, p. 350.
[c] Bull. N. Y. Geol. Survey No. 138, 1896, pp. 32–33.
[d] Ann. Rept. Geol. Survey New Jersey for 1896, 1897, p. 160.

The driller, Mr. Fass, did not penetrate the clay in this well, but pulled up the pipe and obtained the water from the gravel above it.

376. *Record of J. M. Smith's well near Rockville Center.*

Tisbury:	Feet.
1. Stratified, yellow sand and quartz gravel, containing a small percentage of erratic material	0–17
2. Cobble bed; large, yellow, iron-stained quartz bowlders	17–18

Mr. McCarten says that eight or ten attempts have been made to drive wells on the property of Mr. Smith, all of which have been unsuccessful on account of the pipe bending in the attempt to pass through the layer of stones, which is water bearing and 26 inches in thickness. The sand and gravel below the layer of cobbles is said to be relatively dry.

377. The following record has been copied from a blueprint kindly furnished by Chief Engineer I. M. De Varona:

Record of Brooklyn test well No. 26, near Smith Pond.

Recent to Tisbury:	Feet.
1. Muck and sand	0– 15
2. Bluish gray clay	15– 24
3. Yellow sand and gravel	24– 56
Cretaceous?:	
4. Bluish gray clay mixed with fine sand	56– 64
5. Bluish gray and yellow clay mixed with fine sand	64– 71
Cretaceous:	
6. Yellow sand with traces of clay	71– 76
7. Gray sand, gravel, clay, and wood	76– 84
8. Yellow sand, clay, and wood	84– 96
9. Gray sand, bluish clay, and wood	96–108
10. Yellow clay, sand, and wood	108–114
11. Gray sand, clay, and wood	114–118
12. Yellow sand, clay, and wood	118–128
13. Bright-yellow sand, clay, and wood	128–134
14. White sand, clay, and wood (slightly water-bearing from 170.7)	134–184
15. White sand, brown clay, and wood	184–202
16. Solid gray clay; no water	202–214
17. Gray clay, sand, and wood; slightly water-bearing	214–235
18. Gray clay, fine sand, and wood; slightly water-bearing	235–279
19. White sand, clay, and wood; slightly water-bearing	279–510
20. Solid clay of dark bluish gray color	510–518
21. Clay, sand, and wood; slightly water-bearing	518–522
22. Solid clay; no water	522–527
23. Light-gray clay, sand, and wood; slightly water-bearing	527–554
24. Sand, gravel, clay, and wood; water-bearing	554–578
25. Sharp white sand and white clay; no wood; flows 5 gallons per minute	578–579
26. Small gravel, white sand, and white clay; flows 5 gallons per minute	579–587

Elevation of surface, 8.3 feet. "First water at 25 feet; rises to 6 feet below at the surface; the best supply of water is from 42–45 feet."

378. *Record of commission's test well near Rockville Center.*

Wisconsin and Tisbury:	Feet.
1–2. Dark-brown loamy sand	0. 5– 1. 5
3. Reddish yellow fine sand	4. 5
4. Very fine white sand to small gravel	8– 9
5. Very fine grayish yellow sand; some fine gravel	13–14
6. Yellow silty clay, mottled red	17–17. 5

	Feet.
7. Reddish yellow sand	17.5–18
8. Red sand, fine to medium, with biotite	18.5–19
9. Light-yellow sand	22–22.5
10. Same, with considerable yellow clay	23–23.5
11. Red and yellow sand	26.5–27
12. Fine, dark gray-blue clay, with quartz sand and lignite	27 –27.5
13. Grayish sand and lignite	29 –30
14. Light reddish yellow sand, no erratics	33 –34
15–16. Medium white sand	36 –42
17. Medium yellow sand	43.5–44
19. Fine to medium gray sand	47 –48
20. Fine to coarse grayish yellow sand	48 –49
21. Fine to very coarse brownish yellow sand and quartz gravel (bowlder struck in this)	49.5–51
22. Bowlder	51 –52
23. Medium yellow sand	52.5–53
Cretaceous:	
24. Medium white gray sand and a little white clay	53.5–54.5
25. Very fine gray sand and much white clay	55 –55.5
26. Very coarse white sand	55.5–56
27. Fine to coarse quartz sand and gravel	58 –60
28. Fine quartz sand apparently pulverized rock	61 –62
29. Medium grayish yellow sand	65 –66
30. Fine to medium yellowish gray sand and yellow clay	66.5–67.5
31. Medium to coarse yellow sand and clay	71.6–72
32. Dark-gray clay	72.4–74

379. Two of the wells used in this plant were completed in 1895 and the other two in 1892. The village clerk gives the following data regarding the daily pumping during 1902:

Yield in 1902 of wells of Rockville Center waterworks, Rockville Center.

	Gallons.
Maximum daily yield	249,000
Minimum daily yield	112,000
Average daily yield	150,466

380. *Record of commission's test well near Rockville Center.*

	Feet.
1. Black surface loam	0 – 0.3
2. Yellow clayey sand	1.8
3. Medium yellow sand	5.8– 6.3
4. Medium to coarse gray sand	9 –10
5–7. Medium to coarse reddish brown sand; glacial	10 –19
8. Fine gray and brown sand; same as No. 9, well 378	23 –24

381–392. These were test wells put down by the commission on additional water supply around the Millburn reservoir; the deepest was No. 382, of which the section is as follows:

Record of commission's "deep" test well near Millburn reservoir.

	Feet.
1–8. Reddish outwash sand	0 –30
9. Fine gray beach sand	31.5
10. Yellow quartz gravel	34.5–35
11. Fine yellowish gray sand	35.5–36
12. Reddish yellow sand	40 –41
13. Fine brownish yellow sand	41 –42

	Feet.
14–15. Coarser yellowish white sand	46 –51
16. Light gray highly micaceous sand	54 –55
17. Brownish beach sand	56 –57
18–20. Fine, light-gray, highly micaceous sand	58 –69
21. Coarser white sand	73 –74
22. Fine yellowish sand	78 –79
23–25. Fine gray sand with a little white clay	81 –92
26. Dark gray micaceous sand with a little lignite	93 –94
27–28. Very dark-colored sandy clay	95 –97

The materials penetrated in the other wells are summarized in the following table:

Records of commission's wells near Millburn reservoir.

Well number	381.	383.	384.	385.	386.	387.	388.	389.	390.	391.	392.
1. Reddish yellow outwash sand and gravel	0–29	0–31	4–29	0–30	0–22.5	0–21	0–24	0–21	0–29	0–26.5	0–26
2. Fine gray beach sand	29–38	.....	29–32	30–31	22.5–22.5	21–25	24–25	21–22.5	29–30	26.5–32	26–32

See Tables XII, and XIII.

393. Mr. Hancock reports that all shallow wells in this neighborhood are sunk through about the same material and that one description will fit all. They vary in depth from 8 to 20 feet, according to the elevation of the surface.

Record of M. S. Thomas's well at Baldwin.

	Feet.
1. Reddish brown clay; no bowlders	0– 5
2. Loose sand, gray in color	5–10
3. Hard red sand	10–12
4. Red sand with white pebbles	12–13
5. White sand with an abundance of mica	13–18

394. *Record of C. H. Southard's well at Baldwin.*

	Feet.
1. Surface loam	0– 3
2. Fine brown sand	3– 8
3. Very coarse light-colored gravel	8–11
4. Finer gravel, decreasing in size	11–30
5. Very white beach sand	30–35

395. Mr. Wortman reports that at 50 feet he encountered a very black mud which choked the well point. He reports that the clay at Lynbrook is about 12 feet below the surface and is of great thickness. Above the clay is a very coarse stony material. He also reports that a black mud was encountered in driving a well at the railroad station at Baldwin.

396. This well was sounded July 10 by Francis Whitney, field assistant, and found to be 288.6 feet deep from the top of the old pipe. Lignite was reported from 300 to 370 feet.

399. *Record of commission's test well near Norwood.*

	Feet.
Wisconsin:	
1–2. Brown loamy sand	0– 1.4
3–4. Medium reddish yellow sand	5.2– 6.2
5. Fine to medium brownish yellow sand with much biotite	10.5–11.5
Tisbury:	
6. Medium light-brown sand	15 –16
7. Fine to medium rusty red sand	18 –19
8–11. Fine grayish yellow sand (possibly glacial)	20 –34

400. *Record of commission's test well between Rockville and Hempstead.*

	Feet.
Wisconsin:	
1–2. Yellow gravelly loam	0– 2
3–8. Outwash sand and gravel	2–27
Tisbury:	
9. Medium light-yellow sand	31–32

See Tables XII, XIII.

401. *Record of commission's test well south of Hempstead.*

	Feet.
Wisconsin:	
1–2. Yellow gravelly loam	0 – 1.6
3–4. Reddish yellow silty sand	2.5– 6.5
5. Fine reddish brown sand	9.5–10.5
6–9. Dark reddish yellow sand and gravel (glacial)	14.5–22
Tisbury ?:	
10–12. Fine yellowish silt to coarse gravel, becoming lighter and coarser below, not sharply glacial	26 –32

See Tables XII, XIII.

402. *Record of commission's test well near Greenwich Point.*

	Feet.
Wisconsin and Tisbury:	
1–2. Surface dark loamy clay	1.5
3–4. Tough sandy clay with bowlders	2.5–3.4
5–8. Yellow sand to fine gravel	6 –17
9–10. Reddish yellow sand and small gravel, with a considerable percentage of finer material	19 –26
11. Coarse reddish yellow sand (same as No. 7 in well 411)	29 –30

All the section, with the exception of the upper 3.5 feet, appears to be regular outwash material.

403. *Record of commission's test well near Hempstead.*

	Feet.
Wisconsin:	
1. Dark loamy sand	0.4
2–3. Reddish dark-gray sand and gravel	1.5– 9
4. Medium gray sand with considerable glacial débris	10 –11
5–6. Pebbles and fine sand (glacial)	11 –13
Tisbury ?:	
7. Dark reddish sand	15 –16
8. Dark reddish sand and gravel	18 –19
9–10. Medium reddish yellow sand	23 –29
11. Light reddish yellow sand; no erratics (not clearly glacial)	33 –33.5

See Tables XII, XIII.

404. *Record of commission's test well near Hempstead.*

	Feet.
Wisconsin:	
1. Black sandy loam	0 –27
2. Dark silt to cobbles	2.8– 3.2
3–5. Fine to coarse sand, very light yellow	5.5–16
6. Medium reddish sand	17 –18
Tisbury:	
7. Yellow sand and gravel with some erratics	18 –19
Tisbury and Cretaceous:	
8–16. Red sand (doubtfully glacial)	20.5–61

Cretaceous:	Feet.
17. Fine dark-colored sand with lignite	64 –65.5
18–23. Fine, light-colored, silty, micaceous sand, suggesting material of Cretaceous age	67 –94
24. Very black, micaceous, sandy clay	95.5–97

406. *Record of commission's test well near Hempstead.*

Wisconsin and Tisbury?:	Feet.
1–2. Yellow surface loam	0 – 2
3–11. Glacial sand and gravel	2 –52.7

407. *Record of commission's test well near East Meadow Brook.*

Wisconsin:	Feet.
1–2. Light-yellow surface loam	0 – 1.5
3–5. Coarse sand, with some erratic material	5 – 15
6. Considerable gravel, with much erratic material	20
Cretaceous:	
7–14. Fine, white, highly micaceous, clayey sand	22 – 51
15. Dark-brown, very fine, micaceous, clayey sand	55 – 55.5
16. Light-yellow clayey sand	58.5– 60
17. Greenish yellow fine silt to medium sand, highly micaceous	65 – 66
18. Gray silt to medium sand, highly micaceous	70 – 71
19. Bright red sandy silt	75.1– 76
20. Light, grayish brown, micaceous, sandy silt	80 – 81
21–22. Greenish yellow, micaceous, sandy silt	85 – 91
23. Grayish brown, micaceous, silty sand, with some lignite	91.7– 91.8
24. Fine light-yellow sand	93.5– 94
25. Fine, greenish yellow, micaceous, silty sand	95 – 96
26. Dark-gray, micaceous, silty sand	100 –101
27–28. Medium light yellowish white sand	105 –111
29. Brownish white silty sand	115 –116
30. Dark yellowish gray silty sand	120 –121
31. Laminated black and white sandy clay	123.5–125

408. *Record of commission's test well near East Meadow Brook.*

Wisconsin and Tisbury?:	Feet.
1–8. Light-yellow outwash sand and gravel	0–35

409. *Record of commission's test well near Garden City.*

Wisconsin and Tisbury?:	Feet.
1–9. Light-yellow outwash sand and gravel	0–37

See Table XII.

410. *Record of commission's test well at Garden City.*

Wisconsin:	Feet.
1–2. Dark-colored gravelly loam	0 – 1.6
3–7. Brownish-yellow outwash sands and gravel, with much glacial material	2.3–23
Tisbury?:	
8–10. Fine to coarse reddish yellow sand, not clearly glacial	27 –36.8

See Tables XII, XIII.

411. *Record of commission's test well at Garden City.*

Wisconsin and Tisbury:	Feet.
1. Black loamy sand	1
2. Yellow sand to coarse gravel with a little yellow clay	3
3–6. Bright reddish yellow sand and fine gravel	5–21
7. Fine yellow gravel with little, if any, glacial material (same as 11, well 402)	25

413. *Record of commission's test well at Garden City.*

Wisconsin:	Feet.
1. Dark sandy loam with gravel	0.5
2. Yellow sandy clay	2
3. Yellow sand and gravel	4
4–10. Grayish yellow sand to fine gravel	8.5–38.5

All samples apparently represent outwash material, and contain much biotite.

414. Mr. George L. Hubbell, general manager, states that the water level in the well owned by the Garden City Water Supply Company can be reduced 12 feet by excessive pumping, and that when the water level falls after several months' steady pumping the hydrants are opened and the pumps are run at their full capacity night and day for from twenty-four to thirty-six hours. When the normal rate of pumping is resumed the water level rises 5 feet. A layer of clay is encountered between 20 and 24 feet, which is overlain and underlain by sand and gravel.

416. *Record of commission's test well near Mineola.*

Wisconsin and Tisbury?:	Feet.
1. Black surface silt	
2–3. Yellow gravelly loam	1.2– 3.4
4–8. Fine sand to small gravel (outwash glacial material)	6 –27
9. Very fine, reddish, clayey sand	30.9–31
10–12. Fine silt to small gravel (outwash material)	31 –42.5

See Table XII.

418. *Record of commission's test well near Mineola.*

Wisconsin:	Feet.
1. Black surface loam	0.5
2. Yellow, silty, gravelly sand	2 – 2.4
3–10. Fine silt to small gravel (outwash glacial material)	6.5–42
Tisbury:	
11. Very fine, light-yellow, silty sand	50 –51
12. Medium yellow sand (doubtfully glacial)	51 –53.8
13. Coarse reddish yellow sand (doubtfully glacial)	53 –55.7

See Tables XII, XIII.

419. *Record of commission's test well near Mineola.*

Wisconsin:	Feet.
1. Black sandy loam	0.5
2. Dark loamy sand with gravel	2
3. Grayish yellow sand with fine gravel	4 – 6
4. Same, but with more gravel	10 –11.5
5–6. Small gravel with much erratic material	15 –20.5
Tisbury:	
7. Yellow sand with small gravel	20.5–21
8. Same, with a little clay	25.5–26
9–10. Small gravel	29.5–36
11. Very coarse yellow sand	38 –39
12–13. Fine grayish yellow sand	43 –48.5
14. Same, but with a little coarse gravel	53 –53.5

420. *Record of C. Edison's well near East Williston.*

	Feet.
1. Coarse sand	0–
2. Medium sand	–50
3. Coarse sand to gravel; water-bearing	50–56.6

421. *Record of commission's test well near East Williston.*

	Feet.
Wisconsin:	
1. Very dark-brown surface loam	0 – 0.8
2. Reddish brown loamy sand	2.7– 2.9
3–4. Yellow clay and bowlders	7.5–13.2
5. Light yellowish white sand and gravel	17.5–18.5
6. Reddish yellow silty sand	22.5–23.5
7. Very black sand, full of mica, looks like ground-up bowlder	25 –26.5
Tisbury:	
8–9. Fine to medium yellowish white sand	30 –36
10. Fine yellowish white sand to medium gravel	40 –41
11. Small light-colored gravel (considerable percentage of glacial material)	41 –42
12–13. Fine to medium yellowish white sand	45 –51
14. Small light-colored gravel with glacial material	54 –55

See Tables XII, XIII.

422. *Record of commission's test well near Albertson.*

	Feet.
1. Black loamy clay	1.7– 2.3
2. Brownish yellow clay with a few pebbles very similar to the clay at East Williston	3 – 3.5
3. Brown and yellow clay with reddish brown sand and gravel (glacial)	8 – 9.5
4. Dark grayish sand with much fresh biotite; evidently débris from a glacial bowlder	10.5–11.5
5–6. Yellow clay, sand and gravel ("bowlder clay")	15 –21
7. Sand and coarse gravel (glacial)	23 –24
8–10. Fine yellow sand with a noticeable percentage of glacial material	27 –37

See Tables XII, XIII.

423. The greater portion of this well is in light yellow sand and gravel. Near the bottom fine gray sandy clay was encountered.

424. *Record of W. P. Kelsey's well near Old Westbury.*

	Feet.
Wisconsin:	
1. Coarse gravel	0– 50
Cretaceous?:	
2. Alternate layers of sand and clay	50–150

425. *Record of J. E. Brady's well near Old Westbury.*

	Feet.
1. Glacial deposit	0– 20
2. Clay and sand, mixed (white beach sand and greasy, slippery clay)	20–133
3. Coarse gravel, the pebbles of which were highly colored—black, red, and all gradations to yellow	138–145

426. *Record of R. L. Cottnet's well near Old Westbury.*

	Feet.
Wisconsin:	
1. Gravel and large stones	0– 50
2. Black hardpan containing a great many stones and a great deal of mica	50– 62
Mannetto:	
3. Very coarse gravel, quite hard and with no water	62– 75
Cretaceous:	
4. Sand with little water, quite black, and with a bad odor	75– 80
5. Very fine muddy sand	80– 85

Cretaceous—Continued	Feet.
6. Whitish blue clay, lighter than other clays	85– 88
7. White beach sand, water-bearing	88–170
8. Quicksand	170–175
9. A very large stone was encountered at	175
10. Coarse white sand	175–180

427. The following section has been prepared from samples preserved in the museum of the Long Island Historical Society. The location given is only approximate:

Record of J. F. D. Lanier's well near Old Westbury.

Mannetto:	Feet.
1. Yellow surface sand and gravel, no glacial material	0– 10
Cretaceous:	
2. Pinkish white clay interbedded with white sand, suggesting the upper part of the Melville section	10– 22
3. Fine yellow sand with supply of water	22– 37
4. Pinkish white clay, marked "clay in thin layers"	37– 57
5. Fine to medium yellow sand, marked "quicksand"	57–103
6. Ferruginous crusts in clayey sand	103–

That stratum 3 should have contained an abundant supply of water, is rather surprising, considering the height of the well. The probable explanation is that the well was put down in the wet season and that this represents a perched water table.

428. The quicksand in the section below rose in the pipe three or four times. It was at last kept down by putting gravel in the bottom of the well. The water was obtained from quicksand. It was tested for twenty-four hours at a rate of 25 gallons per minute.

Record of J. F. D. Lanier's well near Old Westbury.

Wisconsin:	Feet.
1. Hardpan	0– 20
Transition:	
2. Brown or gray clay, with plenty of flinty stones at the top	20–100
Cretaceous:	
3. Fine white sand	100–146
4. Quicksand, water-bearing	146–150

429. This well is about 40 feet higher than well 430.

430. The following record has been prepared from the samples furnished by Mr. John Tart and the record of Mr. F. Wankel, foremen for the Hudson Engineering and Contracting Company:

Record of H. B. Duryea's well near Old Westbury.

Wisconsin and Mannetto:	Feet.
1. Loam	0– 3
2. Hardpan	3– 27
3. Coarse sand	27– 30
Cretaceous?:	
4. Yellow clay	30– 50
5. Hardpan	50– 76
6. Quicksand	76– 86
Cretaceous:	
7. Medium, very light yellow sand[a]	86– 92
8. Sand with clay layers	92– 97
9. Fine white sand	97–105
10. Medium yellow sand with some clay	105–121
11. Yellow sand with lumps of clay	121–140

[a] No samples above 90 feet.

Cretaceous—Continued.	Feet.
12. Bright reddish brown sand, with some ferruginous sandstone	140–152
13. Medium yellow sand, with lumps of white clay	152–171
14. "Quicksand;" a very fine, light yellow, micaceous, clayey sand	171–190
15. "Sandy white clay;" samples show only very fine, light yellow, micaceous, clayey sand	190–225
16. "Quicksand;" fine to medium, yellow, clayey sand	225–258
17. "Dark clay;" samples show very dark, micaceous, sandy clay	258–280
18. Coarse soapstone sand	280–286
19. Medium to coarse gray sand	286–290
20. Medium to coarse sand	290–308
21. Fine to medium gray sand	308–314
22. White clay	314–324
23. Coarse white sand	324–329
24. Coarse pink and chocolate sand	329–343
25. White clay	343–

Strainers are placed from 300 to 308 feet and from 330 to 340 feet. Elevation of ground, 197.5 feet.

431. The Cretaceous sand which underlies the Wheatley Hills, while water-bearing, is so fine that it is difficult to finish a well in it. Mr. E. D. Morgan has been particularly persistent in his search for a coarser layer that would yield an adequate supply of water. The records of several of the wells drilled at this place are given below.

The section of the well completed by Mr. John Fisher is reported as follows:

Record of E. D. Morgan's well in Wheatley Hills.

Wisconsin:	Feet.
1. Hardpan	0– 80
Cretaceous?:	
2. Reddish clay	80– 92
Cretaceous:	
3. Fine sand	92–295
4. Very white and sticky clay	295–

Water found at the top of the clay.

Five other parties (among whom was Gallienne) made failures in the same locality. Fisher ascribes their failure as due to their having passed through the clay. Below this there is a fine sand which sometimes rises in the pipe to a distance of 100 feet. In one case, where Fisher went through the clay for an experiment, the sand rose in his pipe to a distance of 60 feet. Down to 40 feet in this well the material passed through was so hard that no pipe was required.

A foreman in the employ of Mr. A. J. Connolly reports the following section:

Record of E. D. Morgan's well in Wheatley Hills.

Wisconsin:	Feet.
1. Sand and clay with bowlders	0– 90
Mannetto?:	
2. Coarse gravel, white and yellow	90–
Cretaceous:	
3. Yellow clay with fine sand	
4. Whitish clay (60 feet thick)	
5. Fine white sand with mica particles; water-bearing	–280

Mr. Alfred Wisson reports that in the well which he completed the section is almost the same as that which he reported from well 434. Of the wells drilled by Mr. A. W. Gallienne, Mr. Ed. Danis reports that the material penetrated was very similar to that encountered in the Harriman well (No. 512), on which Mr. Danis was working at the same time.

In the summer of 1903 a new well was drilled at this place by Messrs. Wankel and Tart, of the Hudson Engineering and Contracting Company, who have furnished the Survey with the following record and samples:

Record of E. D. Morgan's well in Wheatley Hills.

[Section by F. Wankel.]

	Feet.
Wisconsin:	
1. Hardpan	0–106
Mannetto:	
2. Beach sand	106–115
3. Hardpan	115–130
Mannetto ? and Cretaceous:	
4. Beach sand	130–201
Cretaceous:	
5. Yellow clay	201–218
6. Beach sand (here I reached the surface of the water)	218–236
7. Gravel	236–243
8. Medium coarse sand	243–252
9. Yellow clay	252–277
10. White clay	277–298
11. Grayish clay	298–316
12. Yellow clay	316–334
13. Gravel, chunks of iron ore, hollow sandstones and big flow of water	334–336
14. Yellow clay	336–344
15. Yellow beach sand, very fine	344–350
16. Coarser	350–360
17. Still coarser	360–364
18. Quicksand	364–368
19. Coarse, yellow sand	368–393
20. Pink sand	393–398
21. White sand, growing continually coarser to almost gravel	398–427
22. White medium coarse sand	427–434
23. White clay, not penetrated	434+

From samples received from Wankel and Tart the following record has been compiled (elevation 328.5 feet, Geological Survey base):

Record of E. D. Morgan's well in Wheatley Hills.

	Feet.
Wisconsin and Tisbury ?:	
1. Quartz, sand, and gravel, with a considerable percentage of glacial material	0–106
Mannetto:	
2. Fine sand to small gravel; quartz, with fragments of red ferruginous sandstone and white chert, and a few compound pebbles	106–115
3. Quartz, sand, and gravel, many pebbles of ferruginous sandstone, and a few fragments of compound pebbles (mica schist)	115–130
Mannetto ?:	
4. Quartz, sand, and gravel, with some pebbles of ferruginous sandstone (no compound pebbles)	130–148
5. Orange-yellow quartz gravel, with a few pebbles of very much decomposed white chert and a few fragments of compound pebbles	148–149
Cretaceous:	
6. Light-yellow quartz, sand, and gravel; white chert (no erratics)	149–170
7. Light-yellow quartz, sand, and gravel (no erratics)	170–201
8. Very light-yellow quartz, sand, and gravel ("water sand")	201–218
9. Fine to medium yellowish-white sand, with a few small pebbles (no erratics)	218–236
10. Small quartz gravel; many pebbles and fragments of white chert	236–243
11. Medium light-yellow sand	243–251

Cretaceous—Continued.	Feet.
12. Yellow sandy clay (very fine yellow sandy silt)	251–277
13. Gray sandy clay (very fine, gray, sandy silt)	277–334
14. Quartz, sand, and gravel with a large percentage of rounded pebbles of ferruginous sandstone. A large fragment (3½ by 2 inches) of a very much decayed, rounded, granitic bowlder was obtained from this layer. This is the only piece of erratic material in the sample	334–336
15. Yellow sandy silt or clay, with a few small quartz pebbles and fragments of ferruginous sandstone	336–344
16. Uniform, fine to medium, yellow sand	344–350
17. Same	350–354
18. Same	354–368
19. Uniform, fine to medium, dirty, white sand	368–375
20. Medium yellow sand	375–393
21. Uniform, coarse, reddish-brown sand	393–398
22. Coarse light-yellow sand	398–418
23. Fine, white and yellow, quartz gravel, with fragments of ferruginous sandstone	418–435

A few specimens are preserved in the museum of the Long Island Historical Society, marked "Specimens obtained in boring a well at Wheatley Hills, Long Island, summer of 1890." These are all normal Cretaceous material, but as no depths are given have no definite stratigraphic value. In one case a small tray marked "460 feet" contained a medium dirty yellow sand. This probably belongs to another section.

432. Mr. Thomas Griffin, foreman for W. C. Whitney, reports that the material penetrated was chiefly "hardpan and fine white sand."

433. Material penetrated very similar to that found in well 432, but the sand is finer and contains a large amount of mica. The water is raised by steam pump and if a greater amount than 4 or 5 gallons per minute is pumped the water becomes cloudy.

434. Mr. Alfred Wisson reports the following section:

Record of S. Mortimer's well in Wheatley Hills.

Pleistocene:	Feet.
1. Hardpan (mixed clay and gravel with occasional streaks of clay)	30–100
Cretaceous:	
2. Soft mushy clay with much mica; the clay was black and had a very bad odor	100–105
3. Soft reddish clay, loam-like in texture with some pure sand intermingled; some clear water was found at the bottom of the clay: yield, about 5 gallons a minute	105–205
4. Good, coarse, white sand with very few pebbles	205–225
5. Blue clay (no stones)	225–226
6. Good clear gravel	226–300
7. Clay	300–

This well was tested for three weeks at a rate of 25 gallons a minute and occasionally 50 gallons a minute No effect was produced on the water level.

The following section is reported by Mr. John Fisher:

Record of S. Mortimer's well in Wheatley Hills.

Wisconsin and Mannetto:	Feet.
1. Coarse gravel and loamy sand, like surface material	0–150
Cretaceous:	
2. Light baky clay; no water on top of the clay	150–160
3. Fine sand	160–200
4. Coarse gravel, about the size of hickory nuts	200–205

Mr. Fisher states that this is the only well in this neighborhood in which water was found in gravel. He regards it as the best well in the vicinity of Wheatley Hills.

435. According to Mr. John Heerdegan the material penetrated in this well is as follows:

Record of W. Stowe's well in Wheatley Hills.

	Feet
Wisconsin:	
1. Bowlders and clay (till)	0– 40
Cretaceous?:	
2. Alternating series of coarse and fine white sands	40–190
Cretaceous:	
3. Fine sand and clay mixed	190–228
4. Material gradually coarser until gravel is reached at 240	228–245
5. Clay and sand mixed	245–295

Water was found in the sandy layers between 245 and 295 feet, but was cloudy, and the well was plugged at 240 feet and a strainer put in from 230 to 240. No water was encountered until a depth of 228 feet was reached. The gravel in this well is reported as coarser than in any of the wells of the Nassau Electric Light and Power Company, No. 437.

Mr. I. H. Ford reports that in the well which he put down at this place he found nothing but sand. The first water was found at a depth of 130 feet.

436. *Record of Mrs. I. Vowman's well near Roslyn.*

	Feet.
Wisconsin and Tisbury:	
1. Coarse red gravel, very hard, and with no stones	0– 20
2. Coarse sand, quite red in streaks	20– 50
Manhasset bowlder bed?:	
3. Sand, with a thin layer of bowlders	50–53
Tisbury and Mannetto:	
4. Fine sand	53– 90
5. Coarse red gravel; water-bearing	90–115

437. *Record of well of Nassau Electric Light and Power Company, Roslyn.*

	Feet.
Pleistocene:	
1. Sand and gravel, similar to that at surface beneath loam (water-bearing between 80 and 82 feet)	0–100
Cretaceous:	
2. Ordinary, white, "beach" sand	100–180
3. Lignite, with sand	180–182
4. Clay, containing a very small percentage of sand ("almost solid clay")	182–220
5. Water-bearing gravel	220–238
6. Fine sand and white clay mixed	238–250

At 250 feet a shell was found in white clay which was identified by Dr. W. H. Dall as *Terebratula filosa*.

According to tests made by the Nassau Light and Power Company the whole series of 4 wells when pumped together yields 176,000 gallons in 24 hours. Individually the wells yield as follows:

Yield of wells of Nassau Electric Light and Power Company at Roslyn.

	Gallons.
Well No. 1	120,000
Well No. 2	70,000
Well No. 3	24,000–25,000
Well No. 4	60,000

The strainers in these wells are 10 feet long and are between 228 and 238 feet below the surface. The wells were sunk to a depth of 250 feet, 12 feet below the strainers, in order that material passing the screens would fall below the screens and not clog up the wells.

438. Mr. Schmidt could not give a complete log of this well, but furnished the following data: Two bowlder beds were encountered, one at 82 feet, 4 feet thick, and another at 124 feet, 2 feet thick. Many of the stones were the size of a double fist and not a few were as large as one's head or even larger. Occasional streaks of clay were encountered, but these were not of any considerable thickness. There were some layers

of coarse sand and gravel of the ordinary color, containing many quartz pebbles the size of hickory nuts One such bed was found at 126 feet, from which the supply of water comes.

Mr. Schmidt says that the above conditions are frequently met with north of the Jericho turnpike, and at least as far east as Westbury. He has also encountered such bowlder beds at East Williston and always found water in them. He says that some of the stones are so large that it is all two men can do to pull one out with the windlass.

440. *Record of commission's test well near Roslyn.*

	Feet.
1–2. Dark sandy loam	0 – 1.4
3. Yellow sandy clay	5 – 5.5
4–5. Fine to coarse reddish-brown sand	7.5–12
6. Fine, reddish-brown, clayey sand with bowlders and cobbles	14 –14.6
7–9. Dark, yellowish gray, fine sand and small gravel, with a considerable percentage of erratics	18 –28.8
10–11. Very fine, light, yellowish-brown, micaceous clayey sand; resembles Cretaceous	34 –40
12–14. Fine to coarse reddish-brown sand, mostly quartz (glacial)	44 –52

441. *Record of commission's test well near Roslyn.*

	Feet.
Wisconsin:	
1. Black surface loam	0.2– 0.8
2–6. Dark, yellowish-brown, clayey sand and gravel containing a very large amount of glacial débris	2 –25

444. Mr. Corcoran reports that a clay bed was encountered between 90 and 190 feet, on penetrating which, water rushed up with considerable force, bringing sand with it.

Mr. Jesse Conklin writes (April 25, 1895), regarding a well at Roslyn, which is probably this well: "In Roslyn, near the Long Island Sound, I drove a 6-inch well 210 feet. At 74 feet I struck water, drove 10 feet in water and got a poor supply. I drove on 116 feet through fine sand and some clay; all through this 116 feet I found clam and oyster shells. At 200 feet I struck white gravel and drove 10 feet and got an unlimited supply of water. I pumped from this well 100 gallons per minute and could not lower the water a particle."

445. *Record of well at W. J. Post's brickyard, Glenwood Landing.*

	Feet.
Tisbury?:	
1. Sand	0– 31
Cretaceous:	
2. Solid clay	31– 61
3. Quicksand	61– 69
4. Coarse gravel	69–

446. *Record of A. A. Knowles's well near Glenhead.*

	Feet.
Wisconsin:	
1. Brownish loam	0– 7
Tisbury:	
2. Yellow sand and gravel	7– 60
Manhasset bowlder bed:	
3. Sand and clay	60– 75
Tisbury:	
4. Sand	75–136
Cretaceous:	
5. Very dark clay	136–137
6. White sand, with water	137–140

450. *Record of Kersona well near Sea Cliff.*

	Feet.
Wisconsin and Tisbury:	
1. Brown sand; slight flow of water at 45 feet	0–45
Cretaceous:	
2. Fine white sand, yielding milky water	45–
3. White and pink clay	–106

452. This plant draws its water from six 6-inch wells sunk between 1897 and 1903, which yield 250,000 gallons in ten hours. The original supply was from springs.

453. Mr. Dubois states that at 80 feet he struck hardpan with some stone. This probably represents the Manhasset bowlder bed.

454. *Record of commission's test well 2 miles south of Locust Valley.*

	Feet.
Wisconsin:	
1–2. Grayish-yellow fine sand to coarse gravel	1. 5–10
Transition:	
3. Medium dark brownish gray sand:	21–25
Tisbury:	
4. Light yellow, very coarse sand and fine gravel; looks like Tisbury material	37–40
5. Same, rather finer	47–52

See Table XIII.

455. *Record of well of Nassau County Water Company, near Glen Cove.*

	Feet.
Recent:	
1. Marsh mud	0– 2
2. Brown sand	2– 8
Tisbury:	
3. Sand and brown gravel	8–35
4. Coarse gravel	35–54
5. Fine gravel	54–

"The gravel [in this well] is as large as a man's fist; the sand is white and coarse from 8 to 54. This well flows 6 feet in the air, and its pumping capacity is 250 gallons per minute."

Samples in the office of Mr. Oscar Darling, consulting engineer, show the following section for the first 10-inch well:

Record of well of Nassau County Water Company, near Glen Cove.

	Feet.
Tisbury:	
1. Light-yellow sand and gravel with small percentage of glacial material	0–23
2 Yellow sandy clay	27
3. Fine yellow sand	31
4. Pepper and salt sand (much glacial material)	37–41
5. Coarse white sand	46–66

This well flowed first at 41 feet.

The 2-inch test well flowed first at a depth of 34 feet; it flowed, at 18 inches above the surface, 20 gallons per minute.

Mr. Darling gives the elevation of the ground at the pumping station as 50 feet above mean high tide.

456. *Record of Friends' Academy well near Locust Valley.*

	Feet.
Tisbury:	
1. Yellow sand	0– 4
2. Light-colored sand and gravel	4– 80
Manhasset bowlder bed?:	
3. Brown clay	80– 87
Tisbury:	
4. Reddish brown sand, with some water	87– 90

	Feet.
Cretaceous?:	
5. Hard sandy clay ("hardpan")	90– 93
6. Gray sand and gravel	93–156
7. Hard sandy clay ("hardpan")	156–160
8. White sand with water	160–164
9. "Hardpan"	164–168
Cretaceous:	
10. Brownish yellow to white sand	168–197
11. White clay, becoming pink below	197–209
12. Greenish white sand, without water	209–212
13. White sand and gravel; water bearing	212–222

457. *Record of F. E. Willets's well near Glen Cove.*

	Feet.
Wisconsin and Tisbury:	
1. Brown loam	0– 9
2. Brownish gravel and sand	9– 29
Manhasset bowlder bed:	
3. "Hardpan;" clay with bowlders	29– 44
Tisbury:	
4. Light-colored sand	44– 70
5. Brownish clay	70– 85
6. Sand, growing whiter as the depth increases	85–158
Cretaceous?	
7. Clay, with enough grit to make it hard ("hardpan")	158–164
8. White gravel (no water)	164–182
9. White coarse sand, with an abundant supply of water	182–186

458. *Record of S. Seeman's well near Glen Cove.*

	Feet.
Wisconsin:	
1. Hard brown clay	0– 15
Tisbury:	
2. Sand and gravel	15–
Transition:	
3. White sand	
Cretaceous:	
4. White clay, becoming pink below	
5. White sand; water bearing	–140

459. *Record of S. Burke's well near Glen Cove.*

	Feet.
Wisconsin:	
1. "Hardpan;" brown clay with grit; no bowlders	0– 41
Tisbury:	
2. Brownish sand and gravel	41–150
Cretaceous:	
3. Whitish clay, becoming pink in its lower portion	150–165
4. White sand, containing water	165–170

Mr. Dubois states that this bed of white or pink clay commonly overlies the water-bearing strata in this section.

460. *Record of North Country Club well near Glen Cove.*

	Feet.
Tisbury:	
1. Surface gravel	0– 20
2. Clay	20– 21
3. Dry brownish-yellow sand	21– 90
Cretaceous:	
4. White clay	90– 94
5. Sand	94–129

462. *Record of John Minniken's well near Glen Cove.*

	Feet.
Recent:	
1. Filled ground	0 - 5
2. Peat	5 -10
Tisbury:	
3. Very light-brown sand	10–70
Cretaceous:	
4. Pink clay	70–78
5. White sand and gravel, water bearing; similar to the gravel in Baldwin's well (No. 476)	78–80

This well flows at a height of about 40 feet above sea level.

463. *Record of Crystal Springs Ice Company's wells near Glen Cove.*

	Feet.
Recent:	
1. Marsh deposit	0–20
Tisbury:	
2. Sand, with water (small flow of fresh water at 28 feet)	20–28
Cretaceous:	
3. Bluish clay, becoming white below	28–70
4. White gravel, with artesian water	70–73
5. White clay (not passed through)	73–

Two-inch well flowed 18 gallons per minute when first drilled, but the flow seems to have decreased slightly; 4-inch well flowed 30 gallons, with no decrease noticed. Water was piped up to 14½ feet above ground in 1899. Mr. Oscar Darling reports the surface at the 4-inch well to be 30 feet above mean high tide.

464. Mr. Ralph D. Carter gives the following section of this well:

Record of J. P. Tangeman's well near Glen Cove Landing.

	Feet.
1. White sand	0– 87
2. Hardpan	87– 90
3. Water-bearing stratum of gravel, sand, and clay, containing mica	90–100
4. Gray-colored clay	100–105

465. *Record of W. M. Valentine's well near Dosoris.*

	Feet.
Wisconsin and Tisbury:	
1. Brown loam	0– 6
2. Gray to brown sand and gravel	6– 76
Manhasset bowlder bed:	
3. "Hardpan"	76– 79
Tisbury:	
4. Brownish sand with water	79– 83
5. Some gravel at about	125
Cretaceous:	
6. Very white clayey sand	144–200
7. Blue clay, with a very hard layer at the base	200–215

466. This plant was originally constructed to supply the Pratt estate, but the mains were ultimately extended to Lattingtown and Glen Cove.

Mr. Frederick Miller put in the first two wells near the pumping station, after he had made the two tests mentioned under well 467. These were both 6-inch wells, one 38 and the other 48 feet deep. The 38-foot well has an elevation of about 48 feet, and flowed when first put down. Since the wells have been pumped, this well has ceased flowing.

In 1900 Mr. Munger put in two additional 6-inch wells, one 38 feet and the other 82 feet deep. The 82-foot well is on the lowest ground of the series, being only about 30 feet above high tide; it is reported to flow 4 to 5 gallons per minute. Its section is approximately as follows:

Record of Pratt estate well near Dosoris.

	Feet.
1. Soil	0– 2
Cretaceous:	
2. Blue clay	2–17
3. Reddish sand and gravel	17–19
4. Blue clay	19–30
5. Fine white sand	30–36
6. Alternate layers of gravel, sand, and clay	36–82

Water was first struck at about 40 feet, but did not flow; at 70 feet water was again encountered, which filled the pipe almost to the top; at 75 feet the water flowed over the top of the pipe. The yield of these 4 wells is given as about 100,000 gallons per day.

The standpipe, which has a capacity of 158,000 gallons, is situated on the top of a hill, at an elevation of 160 feet. About 250 feet southwest of one of the good wells at the pumping station, Mr. Munger put down four 1½-inch test wells to a depth of 125 feet without getting water. He reports the same character of soil, but no water.

467. Mr. Munger reports two wells sunk at this point to a depth of 125 feet, through sand and clay, without any results.

469. *Record of D. F. Bush's well near Dosoris Pond.*

	Feet.
Recent:	
1. Yellowish brown sand	0 – 4
2. Marsh deposit	4 – 7
Wisconsin?:	
3. Blue clay with pebbles ("hardpan")	7 –15
Tisbury:	
4. Quicksand	15 –85
Sankaty:	
5. Reddish gravel and clay	85 –88
6. Very red sand	88 –88.5
7. Reddish gravel and clay	88.5–95
Jameco:	
8. Light-colored gravel with a considerable percentage of glacial material; furnishes artesian water	95 –97

Mr. Dubois has furnished a sample from stratum 8.

470. The following section has been compiled from samples furnished through the kindness of Messrs. P. H. and J. Conlan:

Record of C. O. Gates's well near Peacock Point.

	Feet.
Pleistocene:	
1. Sand and gravel	0– 40
2. Greenish gray sandy clay, with a few quartz pebbles	45
3–5. Dark, reddish brown sandy clay, with some biotite	60 – 80
Transition:	
6. Fine gray sand	90
Cretaceous:	
7. Laminated, reddish brown, sandy clay; no biotite	95
8. Very fine, pinkish white, micaceous sand	100
9–14. Light-gray, medium, micaceous sand	105–130
15. Dark, grayish brown, sandy clay	135
16. Pebbles of ferruginous sandstone	140
17–20. Laminated red and white clay. In the fragments furnished, the laminations show very great distortion; whether this is the natural condition of bed or is the result of method of taking samples is not known. Sample 17 contains a few fragments of a lamellibranch, but the sample shows	

evidence of having been laid out on the ground before it was packed in the bottle, and the shell may have been picked up there..... 145–160
21–26. Brick red, very plastic clay..... 165–190
Lloyd sand:
27–30. Fine reddish sand; the red color seems to be due in a great measure to the red clay from the overlying bed..... 195–210
31–33. Medium light-yellow sand..... 215–225
34. Fine to coarse, light yellow, quartz gravel, with a few fragments of white, chalky looking chert..... 230–
Elevation 9.0 feet, Geological Survey base.

Mr. Bowman reports that the well flows 30 gallons per minute. For partial analysis by Prof. Charles S. Slichter, see page 68.

471. Mr. E. K. Hutchinson reports the following section for this well:

Record of C. O. Gates's well near Peacock Point.

	Feet.
Pleistocene:	
1. Fine sand and gravel	0– 80
Cretaceous:	
2. Alternate layers of red, black, gray, and milky-white clay	80–200
Lloyd sand:	
3. Fine sand, gradually growing coarser	200–225

472. Water brings up a fine, micaceous, white sand, which settles with difficulty. It is claimed that storms from the north do not affect the water, but that storms from the east cause it to be very turbid.

Record of well near Peacock Point.

	Feet.
Pleistocene:	
1. Beach sand and gravel	0–138
Cretaceous:	
2. Red clay	138–198
Lloyd sand:	
3. Sand with artesian water	198–210

473. Mr. Hutchinson reports the following section:

Record of W. D. Gutherie's well near Lattingtown.

	Feet.
Wisconsin and Tisbury:	
1. Sand and gravel	0– 80
Cretaceous:	
2. Clay, blue, white, and red, encountered in order given	80–260
Lloyd sand:	
3. Varicolored sand and gravel, becoming coarser	260–340

This well began flowing at 260 and continued to 340 feet.

One of the workmen engaged on well gives the following record:

Record of W. D. Gutherie's well near Lattingtown.

	Feet.
Wisconsin and Tisbury:	
1. Sand and gravel	0–110
Cretaceous:	
2. White, blue, brown, and red clay, encountered in the order given	110–260
Lloyd sand:	
3. White and yellow sand, in layers of 3 or 4 feet, alternating with layers of white clay.	260–342

Elevation 13.0 feet, Geological Survey base.

474. *Record of W. D. Gutherie's well near Lattingtown.*

	Feet.
Recent:	
1. Swamp muck	0– 5
Wisconsin and Tisbury:	
2. Brownish sand	5–60
Cretaceous?:	
3. Blue clay with gravel, not passed through	60–92

At 13 feet the water rose in a pipe 2 feet above the surface, and at 25 feet, 2.5 feet.

475. *Record of W. Price's well near Lattingtown.*

	Feet.
Wisconsin?:	
1. Brown clay	0– 15
Transition:	
2. White sand	15– 35
Cretaceous:	
3. Blue clay	35– 37
4. Light-colored clay	37–
5. Pink clay	–160
6. Light-yellow gravel	160–162

Elevation of surface 140 feet above mean sea level.

476. Mr. W. H. Baldwin, jr., has kindly furnished the following record of this well:

Record of well of W. H. Baldwin, jr., near Lattingtown.

	Feet.
Wisconsin:	
1. Brown loam	0– 3
2. Gravelly loam	3– 7
Transition:	
3. Yellowish sand and gravel	7– 12
Tisbury:	
4. Sand and gravel, with occasional thin streaks of clay	12–107
5. White gravel, hard and flinty	107–120
Cretaceous:	
6. Clay	120–130
7. Yellow sticky sand, with some water	130–134
8. Gravel, with occasional streaks of very hard hardpan	134–199
9. Very hard clay bed	199–255
10. White sand	255–257
11. Gray sand	257–260
12. White and pink gravel	260–265

Elevation of surface 179.5 feet above sea level, Geological Survey base.

Analysis of water from well of W. H. Baldwin, jr., near Lattingtown.

	Parts per million.
Total solids	48.00
Chlorine	7.60
Nitrogen as free ammonia	.022
Nitrogen as albuminoid ammonia	.024
Nitrogen as nitrites	.003
Nitrogen as nitrates	3.300
Odor and color	None.

The solid matter is all in solution and is practically all sulphates. The amount (2.8 grains per gallon) is extremely small. This is an unusually soft water (almost as soft as rainwater) and bears no evidence of contamination.—*C. N. Forrest, chemist and inspector, Long Island Railroad.*

479. *Record of L. C. Wier's well near Lattingtown.*

	Feet.
Pleistocene:	
1. Same as No. 481	0–124
Cretaceous:	
2. White clay	124–130
3. White sand	130–132

480. *Record of L. C. Wier's well near Lattingtown.*

	Feet.
1. Sand with an occasional stratum of impervious clay	0 –117.2
2. Beach sand and gravel	117.2–123.6

481. *Record of L. C. Wier's well near Lattingtown.*

	Feet.
Tisbury:	
1. Sand and gravel	0 –60
Manhasset bowlder bed? :	
2. Red clay with gravel (hardpan)	60 –63
Tisbury and Mannetto? :	
3. White sand and gravel	63 –73
4. Orange sand with water	73 –91.9
Cretaceous:	
5. White clay	91.9–

482. Record is reported as very similar to that of 481.

483. *Record of E. Latting's well near Lattingtown.*

	Feet.
Tisbury:	
1. Sand and gravel	0–60
Manhasset bowlder bed:	
2. Red clay and gravel	60–63
Tisbury:	
3. White sand and gravel	63–73
Mannetto? :	
4. Orange sand with water	73–126
Cretaceous:	
5. White clay	126–132
6. White sand	132–138

484. *Record of W. D. Gutherie's well near Lattingtown.*

	Feet.
Tisbury:	
1. White gravel	0–60
Manhasset bowlder bed:	
2. Red clay with gravel (hardpan)	60–64
Tisbury and Mannetto? :	
3. White sand	64–83
Mannetto? and Cretaceous:	
4. Orange-colored sand	83–108
Cretaceous:	
5. White clay	108–

485. *Record of W. D. Gutherie's well near Lattingtown.*

	Feet.
Tisbury:	
1. Stratified sand and gravel	0– 38
Manhasset bowlder bed:	
2. Large bowlder	38–
Tisbury:	
3. Sand and gravel	–100

Cretaceous:	Feet.
4. White clay	100–110
5. Orange-colored sand; water bearing	110–144

487. Mr. Ward reports that the plant at this station consists of thirty-two 6-inch wells, 33 to 91 feet deep. Samples from a number of these are preserved in the archives of the Brooklyn department of water supply, and while the sections shown are quite irregular, the following selected records will indicate something of their general nature:

Record of well No. 2 E, Agawam pumping station.

	Feet.
1. No samples	0–35
2. Fine, gray, micaceous sand, and medium to coarse yellow sand	35–40
3. Fine, gray, micaceous sand	40–45
4. Dark yellowish-gray silt to small gravel	45–55
5. Very white, medium, micaceous sand	55–60
6. Yellowish-white, medium, micaceous sand	60–65
7. Mixture of medium yellow and fine gray sand with some small pebbles	65–90

Nothing recognizably glacial.

Record of well No. 10 E, Agawam pumping station.

	Feet.
1. No samples	0–30
2. Dark-gray clay	30–35
3. Fine, gray, micaceous sand	35–45
4. Fine yellow sand	45–50
5. Dirty grayish yellow sand and gravel	50–65
6. Blue clay	65–70
7. Fine grayish-yellow sand	70–75
8. Fine orange-yellow sand	75–80
9. Medium grayish-yellow sand, with a considerable percentage of very small orange-colored pebbles	80–94

Record of well No. 5 W, Agawam pumping station.

	Feet.
1. No samples	0–54
2. Very fine, gray, micaceous sand	54–65
3. Light-yellow to orange, small, quartz gravel	65–69
4. Fine gray sand, with lignite	69–79
5. Same as 3	79–84
6. Gray and yellow fine to medium sand, with lignite	84–89

Record of well No. 10 W, Agawam pumping station.

	Feet.
1. No samples	0– 30
2. Fine grayish yellow sand with a few pebbles	30– 35
3. Very fine dark-gray sand	35– 45
4. Gray to light yellowish gray fine sand	45– 80
5. Fine, light, yellow or grayish yellow sand	80–106

Record of well No. 11 W, Agawam pumping station.

	Feet.
1. No samples	0–24
2. Orange sand and gravel	24–35
3. Fine, dark, gray and light gray sands in alternating beds	35–80

Record of well No. 12 W Agawam pumping station.

	Feet.
1. No samples	0– 35
2. Fine yellowish gray sand	35– 45
3. Fine gray sand	45– 60
4. Fine dark-gray sand, with considerable lignite	60–110

This section is much more uniform than the other rapidly alternating sections of the same series.

Record of well No. 6 B, E, Agawam pumping station.

	Feet.
1. No samples	0–24
2. Fine gray micaceous sand, with a little yellow sand	24–62
3. Fine to coarse yellow and orange sand	62–90

488. This was the site of the original Freeport or Agawam station, and was abandoned because of the large amount of chlorine which the water contained. The following summarized section has been prepared from the samples preserved by the Brooklyn waterworks:

Record of wells at old Freeport pumping station.

	1 E.	2 E.	3 E.	4 E.	5 E.	6 E.	7 E.	8 E.	9 E.	10 E.	11 E.	12 E	13 E.
1. Bleached or humus-stained gravel and sand	.....	.....	0– 5	0– 5	0– 6	0– 5	0– 5	.....	0– 5	0– 5	0– 5	0– 5	.....
2. Light-yellow to orange-yellow sand and gravel; apparently all quartz, no erratics	0–28	0–28	5–27	5–27	6–27	5–24	5–30	0–30	5–28	5–28	5–29	5–25	0–27
3. Bright-orange sand and gravel not always sharply separated from bed above, but generally coarser; quartz, no erratics	28–34	28–34	27–31	27–31?	27–30	24–30?	.....	.....	28–30	28–30	.....	25–27	27–30
4. Fine, gray, micaceous sand, with a little yellow gravel (transition?)	34–36	34–36	31–34	31–33	30–33	30–33	30–33	30–33	30–33	30–33	29–31	27–31	30–32

	14 E.	15 E.	16 E.	17 E.	18 E.	19 E.	20 E.	1 W.	2 W.	3 W.	4 W.	5 W.	6 W.
1. Bleached or humus-stained gravel and sand	0– 5	0– 5	0– 3	0–? 5	(?)	0– 5	0–? 5	0– 4	0– 5	0– 4	0– 5	0– 5	0–? 5
2. Light-yellow to orange-yellow sand and gravel; apparently all quartz, no erratics	5–25	5–26	3–23	5–24	0–26	5–25	5–29	4–33	5–39	[a]4–35	[a]5–35	[a]5–34	5–40
3. Bright-orange sand and gravel not always sharply separated from bed above, but generally coarser; quartz, no erratics	25–27	[a]26–30	23?–30	24–29	26–29	25–29	.....	.....	.....	[a]35–38	[a]35–39	[a]34–39	40–4?
4. Fine, gray, micaceous sand, with a little yellow gravel (transition?)	27–31	30–32	30 –32	29–32	29–32	29–31	29–31	33–36	.....	38–40	39–42	39–42	.....

	7 W.	8 W.	9 W.	10 W.	11 W.	12 W.	13 W.	14 W.	15 W.	16 W.	17 W.	18 W.	19 W.	20 W.
1. Bleached or humus-stained gravel and sand	0– 9	[b]0– 9	[b]0– 9	0– 5	0– 5	0– 4	0– 4	[b]0– 9	[b]0– 8	[b]0–10	[b]0– 8	[b]0–10	[b]0–10	[b]0– 5
2. Light-yellow to orange-yellow sand and gravel; apparently all quartz, no erratics	9–37	9–31	9–32	5–39	5–36	4–38	4–35	9–30	8–30	10–30	8–35	10–34	10–38	5–40
3. Bright-orange sand and gravel not always sharply separated from bed above, but generally coarser; quartz, no erratics	.....	31–39	[a]32–37	.....	(c)	.....	35–39	30–39	[a]30–38	[a]30–36	35–40	34–38	38–40	.....
4. Fine, gray, micaceous sand, with a little yellow gravel (transition?)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[a] Medium sand.
[b] Weathering shows sharply to 5 feet and less markedly to depth indicated.
[c] 37 to 40 feet white quartz gravel tinged with yellow.

Analysis of water from wells of old Freeport pumping station.

[By Brooklyn health department.]

	Parts per million.
Total solids	253.941
Loss on ignition (organic and volatile matter)	46.765
Mineral matter	207.176
Free ammonia	.017
Albuminoid ammonia	.019
Chlorine as chlorides	110.206
Sodium chloride	181.528
Nitrogen as nitrates	.798
Nitrogen as nitrites	None.
Total hardness	39.382
Permanent hardness	36.647

489. The plant at this station consists of sixty-two 4½-inch wells. The following summarized record has been prepared from the samples preserved by the Brooklyn waterworks:

Record of wells at Merrick pumping station.

	Test wells.										Service wells, east.			
	1 E.	2 E.	3 E.	4 E.	Center.	1 W.	2 W.	3 W.	4 W.	No. 6	1 E.	2 E.	3 E.	4 E.
1. Fine sand to small gravel, commonly quite coarse and containing a very small percentage of material of probably glacial origin (outwash)	0–9	0–9	0–9	0–10	.....	0–5	0–5	0–12	0–10	(a)	0–10	0–10	0–10	0–9
2. Light-yellow to orange, fine to medium, sand with some gravel gradually passing into bed below	9–43	9–40	9–40	10–41	0–45	5–49	5–46	12–36	10–35	(a)	10–45	10–40	10–40	9–40
3. Gray clay	.....	.....	.....	.....	.....	.....	.....	.....	.....	(a)	.....	.....	.....	40–45
4. Fine to medium gray sand with some lignite in deeper wells	43–48	40–47	40–45	41–45	.....	49–50	46–48	36–47	35–41	36–105	.....	.....	.....	.....

	Service wells, east.													
	5 E.	6 E.	7 E.	8 E.	9 E.	10 E.	11 E.	12 E.	13 E.	14 E.	15 E.	16 E.	17 E.	18 E.
1. Fine sand to small gravel, commonly quite coarse and containing a very small percentage of material of probably glacial origin (outwash)	0–10	0–10	0–10	0–15	0–8	0–9	0–9	0–15	0–11	0–11	0–10	0–? 12	0–10	(b)
2. Light-yellow to orange, fine to medium, sand with some gravel gradually passing into bed below	10–45	10–45	10–45	15–43	8–40	9–40	9–40	15–41	11–40	11–40	10–40	12–39	10–40	10–40
3. Gray clay	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4. Fine to medium gray sand with some lignite in deeper wells	.....	.....	.....	43–45	40–45	40–45	40–44	41–45	40–45	40–45	40–45	39–45	40–45	40–45

a Missing.

Record of wells at Merrick pumping station—Continued.

	Service wells, east.													Service wells, west.
	19 E.	20 E.	21 E.	22 E.	23 E.	24 E.	25 E.	26 E.	27 E.	28 E.	29 E.	30 E.	31 E.	1 W.
1. Fine sand to small gravel, commonly quite coarse and containing a very small percentage of material of probably glacial origin (outwash)	0–10	0–11	0–? 10	0–11	(a)	0–11	0– 9	0–10	0–? 10	0–? 10	0–10	0–10	0–10	0–9
2. Light-yellow to orange, fine to medium, sand with some gravel gradually passing into bed below	10–40	11–40	10–40	11–40	10–40	11–40	9–40	10–40	10–40	10–40	10–40	10–40	10–40	45
3. Gray clay														
4. Fine to medium gray sand with some lignite in deeper wells	40–45	40–45	40–45	40–45	40–45	40–45	40–45	40–45	40–45	45	45	45	45	

	Service wells, west.														
	2 W.	3 W.	4 W.	5 W.	6 W.	7 W.	8 W.	9 W.	10 W.	11 W.	12 W.	13 W.	14 W.	15 W.	16 W.
1. Fine sand to small gravel, commonly quite coarse and containing a very small percentage of material of probably glacial origin (outwash)	0–15	0–10	(?)	0– 9	0–10	0– 10	(?)	0– 5	0– 9	0–10	(?)	0–10	0– 8	0–10	0– 8
2. Light-yellow to orange, fine to medium, sand with some gravel gradually passing into bed below	40	10–40	0–40	9–40	10–40	10– 40	0–40	5–40	9–45	10–45	0–45	10–45	7–45	10–40	8–45
3. Gray clay														40–45	
4. Fine to medium gray sand with some lignite in deeper wells		40–45		40–45	40–45	40–107	40–45	40–45						45–110	

	Service wells, west.														
	17 W.	18 W.	19 W.	20 W.	21 W.	22 W.	23 W.	24 W.	25 W.	26 W.	27 W.	28 W.	29 W.	30 W.	31 W.
1. Fine sand to small gravel, commonly quite coarse and containing a very small percentage of material of probably glacial origin (outwash)	0– 6	0–16	0–10	(?)	0–10	0–? 10	(?)	0–10		0–10	0–13	(?)	(?)	0–10	(?)
2. Light-yellow to orange, fine to medium, sand with some gravel gradually passing into bed below	6–45	16–45	10–43	0–40	10–45	10–45	0–40	10–40	0–40	10–40	13–40	0–37	0–40	10–41	0–41
3. Gray clay															
4. Fine to medium gray sand with some lignite in deeper wells			43–45	40–45			40–45	40–45	40–45	40–45	40–45	37–45	40–45	41–45	41–45

a Very fine white silt with gravel of very doubtful origin.

The elevation of a number of the wells is given below:

Elevation of wells at Merrick pumping station.

	Feet.
7 E.	13.5
15 E.	15.5
7 W.	14.2
15 W.	14.8

During the month of June, 1900, when the station was not in use, the average height of the water in the deep wells was 9.01 feet above the Brooklyn base; in the shallow wells, 7.11 feet. In August, 1900, after pumping had begun, the average height of the water in the deep wells was 3.98 feet above, and in the shallow wells 2.32 feet below, the Brooklyn base.

490. The plant of the Merrick Water Company consists of 8 or 10 shallow wells pumped by a 16-foot windmill; the water is discharged into a number of tanks and is distributed by a 3-inch pipe to the adjacent cottages.

491. According to Ward, the plant at this station consists of forty-six 4½-inch wells, 38 to 97 feet deep. When not pumped all of the deep wells will flow at a height of 11.11 feet above the Brooklyn base. The following summarized section has been prepared from the samples preserved by the Brooklyn water department:

Record of wells at Matowa pumping station.

	1 S.	2 S.	3 S.	4 S.	5 S.	6 S.	7 S.	8 S.	9 S.	10 S.	11 S.	12 S.	1 W.
1. Orange sand and quartz gravel	0–35	0–35	0–35	0–35	0–35	0–35	0–35	0–35	0–31	0–35	0–35	0–30	0–35
2. Transition	35–40	35–45	.....	35–44	35–44	.....	35–44	35–55	31–38	.....	.....	.....	.....
3. Very dark-gray sand	40–50	45–50	.....	44–55	44–99	.....	44–50		.....	35–38	35–38	30–38	35–36
4. Medium gray sand, with occasional particles of lignite	50–100	50–98	.....	55–100		.....	50–97	55–104	.....	.....	.....	.....	.....

	2–3 W.	5–6 W.	11 W.	14 W.	18 W.	1 E.	2 E.	3 E.	4 E.	5–7 E.	8 E.	9 E.	10–19 E.
1. Orange sand and quartz gravel	0–30	0–30	.....	0–30	0–30	0–35	0–36	0–35	0–40	0–40	0–30	0–35	0–35
2. Transition	30–35	30–35	.....	.....	.....	35–38	36–39	35–40	.....	.....	30–40	.....	.....
3. Very dark-gray sand	35–98	.....	.....	30–50	.....	.....	.....	.....	.....	.....	.....	.....	.....
4. Medium gray sand, with occasional particles of lignite		35–98	.....	50–73	30–104	.....	.....	.....	.....	.....	.....	35–40	35–40

492. *Record of commission's test well at Matowa pumping station.*

	Feet.
1–2. Sandy peat	0– 5
3–4. Light yellow sand and gravel	6–10.5
5–8. Reddish-yellow sand and gravel	11–24

The whole section is probably of glacial origin, although the lower samples show a very small percentage of glacial material.

493. According to Ward, the plant at this station consists of forty-three 4½-inch wells, 24 to 89 feet deep, and six 6-inch wells 92 feet deep. The shallow wells do not flow, but the deeper wells do when the station is not in operation. The following section has been prepared from the samples preserved by the Brooklyn water department:

Record of wells at Wantagh pumping station, New York.

	12 E.	14 E.	16 E.	18 E.	20 E.	14 W.	16 W.
1. Grayish yellow sands and gravels, in part glacial.	[a] 0–25	[a] 0–25	[a] 0–30	[a] 0–25	[a] 0–25	0–20	0–25
2. Fine dark-gray sands, occasionally showing yellow sands, possibly from the bed above	25–49	25–40	30–40	25–40	25–40	20–40	25–46
3. Dark-gray clay or silty clay; containing a few quartz pebbles in S series of wells	[b] 49–50	40–50	[b] 40–50	[b] 40–50	40–50	40–50	46–50
4. Fine gray sands, occasionally yellow or reddish yellow	50–91	50–100	50–70	50–65	50–65	50–66	50–75
5. Sandy clay						66–70	
6. Same as 4						70–90	

	18 W.	20 W.	22 W.	1 S.	2 S.	3 S.	4 S.	5 S.
1. Grayish yellow sands and gravels, in part glacial.	0–20	0–20	0–20	0–20	0–20	0–20	0–25	0–20
2. Fine dark-gray sands, occasionally showing yellow sands, possibly from the bed above	20–40	20–41	20–50	20–40	20–40	20–40	25–55	20–45
3. Dark-gray clay or silty clay; containing a few quartz pebbles in S series of wells	40–44	[b] 41–45	[c] 50–55	[d] 40–56	[d] 40–56	[d] 40–56	55–60	45–55
4. Fine gray sands, occasionally yellow or reddish yellow	44–85	45–85	55–90	56–90	56–91	55–90	[c] 60–70	55–85
5. Sandy clay							70–75	
6. Same as 4							75–90	

[a] No samples.
[b] Quite sandy.
[c] Very fine dark silt.
[d] Quite sandy; central portions with pebbles.

The deep test well No. 2 at this station has an elevation of 7.69 feet, and furnishes flowing water when the station is not in operation. In September, 1900, when the station was actively pumping, the average height of the water in the deep wells was 1.8 feet above the Brooklyn base, while in the shallow wells it was 2.8 feet below the Brooklyn base.

494. *Record of commission's test well at Wantagh pumping station.*

	Feet.
1–3. Sand and gravel with some peat	3– 5
4–6. Reddish-brown fine to coarse sand	9. 5–20

495. According to the report of the commission's inspector this well began to flow at 62 to 63 feet.

Record of commission's test well at Wantagh pumping station.

	Feet.
1–5. Dark, reddish brown, swamp-stained sand and gravel, for the most part quartz.	0–16
6–8. Very light-yellow quartz gravel, with very few, if any, erratics	16–30
9. Very fine, dark-gray, micaceous sand	30–31
10. Yellowish gray sand and fine gravel	32–33
11–13. Very fine, dark-gray, micaceous sand	34–46
14. Blue clay, with quartz pebbles	48–60
15–18. Very fine, dark-gray, micaceous sand, with lignite	63–71

See Table XIII.

496. From the upper part of this well no samples were received, but Prof. C. S. Slichter has furnished the following data: "Clay was encountered at a depth of 44 feet. At 62 feet an artesian head of about 32 inches was developed."

Record of commission's test well near Wantagh pumping station.

	Feet.
No samples	0–64
1. Very fine, dark-gray, micaceous sand	64–64.5
2. Grayish yellow fine sand to small gravel (glacial?)	67–67.5
3. Light-gray silty sand	72–73
4. Medium, white, micaceous sand	77–78
5. Medium, yellowish white, micaceous sand	82–83

497. *Record of commission's test well near Wantagh pumping station.*

	Feet.
1. Humus-stained loamy sand	0– 0.25
2. Gravelly loam	2– 3
4–5. Brownish yellow outwash sand and gravel	5.5–13

498. *Record of commission's test well near Camp Meeting grounds.*

	Feet.
1. Humus-stained loamy sand	0– 5
2. Yellow sandy loam	1– 1.5
3–5. Grayish yellow outwash sand and gravel	4–17

499. *Record of commission's test well near Smithville South.*

	Feet.
1. Humus-stained loam	0 – 4
2. Yellow clayey loam	1.4– 2.4
3. Grayish yellow sand and gravel (outwash)	5 –14.25

500. This was one of the wells put down at Camp Black during the Spanish-American war; its exact ocation was not learned.

Record of United States Army well on Hempstead Plains.

	Feet.
1. Top soil	0– 3
2. White coarse sand and gravel	3–15
3. Slate-colored clay	15–17
4. White sand and gravel	17–22

501. *Record of commission's test well near Hicksville.*

	Feet.
Wisconsin and Tisbury:	
1. Surface loam	0 – 5
2–10. Outwash sand and gravel	2.5–41
11. Fine to coarse yellowish sand with small particles of glacial material	45 –46
Cretaceous?:	
12–13. Fine light-yellow sand with considerable mica (probably not glacial); suggests the older sands exposed in the Melville section	50 –56

See Table XII.

502. *Record of commission's test well near Hicksville.*

	Feet.
Wisconsin:	
1–3. Sandy loam	0 – 3
4–6. Light-yellow outwash sand and gravel	4.5– 11
Tisbury:	
7–8. Sand and gravel with a considerable percentage of black silt; looks very much like an old land surface (no glacial pebbles)	15 – 22
9–15. Very light, yellowish white, fine sand to small gravel, containing a very small percentage of glacial pebbles	25 – 57

	Feet.
Cretaceous?:	
16. Very fine yellowish white sand, with a little lignite	59 – 61
17–25. Light, yellowish white, speckled, fine sand and small gravel; gravel is white quartz, with occasional particles of ferruginous sandstone; no pebbles of recognizable glacial material	64. 5–100
Cretaceous:	
26–32. Uniform, light-yellow to white, micaceous sand	101 –131. 0
33. Fine sand to small gravel, containing a considerable number of small, ferruginous, sandstone fragments, which give sample a speckled appearance.	132. 5–135. 5

See Table XII.

503. Samples preserved in the office of Mr. Oscar Darling, consulting engineer, show the following section:

Record of Nassau County Water Company's well near Hicksville.

	Feet.
Wisconsin and Tisbury:	
1. Glacial sand and gravel	0–85

The well plant consists of two 8-inch wells placed in the bottom of a pit 50 feet deep, in which the direct suction pump is also placed. An Acme system is used having a storage capacity of 25,000 gallons.

505. *Record of well of H. J. Heinz Company near Hicksville.*

	Feet.
Wisconsin and Tisbury:	
1. Sand and gravel	0–90
Cretaceous:	
2. Sand and clay	90–

506. *Record of commission's test well near Hicksville.*

	Feet.
Wisconsin and Tisbury:	
1. Light-yellow surface loam	0. 5– 1
2. Dark, humus-stained, loamy sand	1. 8– 2. 2
3–13. Light-colored outwash sand and gravel	3 –53
Cretaceous:	
14–16¼. White, micaceous, clayey sand, pronouncedly Cretaceous in character	59 –75
17–18. Fine, micaceous, reddish-brown, clayey sand	75 –80. 5

See Table XII.

507. *Record of Jos. Steinart's well near Hicksville.*

	Feet.
Wisconsin and Tisbury:	
1. Gravel	0– 75
Cretaceous:	
2. Gravel with lignite and white clay, water bearing; water would not clear	75–120
3. Very black clay	120–130
4. Gray sand with abundant supply of water	130–150

508. Mr. F. K. Walsh reports the following section:

Record of St. John's Protectory well near Hicksville.

	Feet.
Wisconsin and Tisbury:	
1. A very compact sand with no gravel and no clay	0–75
2. Water-bearing gravel	75–80

509. *Record of well of Colored Children's Home near Westbury.*

	Feet.
Wisconsin:	
1. Sharp dirty-white sand	0–20
Cretaceous?:	
2. Mixture of gray quicksand and clay	20–60

511. The following section has been prepared from the record and samples furnished by Mr. George H. Pease, foreman:

Record of W. P. Thompson's well near Old Westbury.

	Feet.
Wisconsin:	
1. Bowlder clay	0– 23
Mannetto:	
2. Yellow quartz sand and gravel (no glacial material)	23– 56
Cretaceous?:	
3. Yellow silty clay, resembling loess	56– 98
Cretaceous:	
4. Fine to coarse yellow sand	98–108
5. Very coarse light-yellow sand, with some gravel; slightly water bearing	108–128
6. Fine sand	128–131
7. Fine light-yellow sand; slightly water bearing	131–144
8. Coarse sand; water bearing	144–190
9. Coarse light-yellow sand and gravel, becoming finer below	190–209

Strainer was placed between 195 and 205 feet. The well tested about 60 gallons per minute. Test was made on two consecutive days, and each test was continued ten hours.

512. *Record of J H. Harriman's well in Wheatley Hills.*

	Feet.
Wisconsin and Mannetto:	
1. Loam and bowlders (some yellow gravel)	0– 70
Cretaceous?:	
2. Clay, with very little grit and no gravel (yellow, almost a loam, resembling loess in color but not in texture)	70–130
Cretaceous:	
3. White gravel, with layers of white clay	130–200
4. White sand with water	200–220

513. *Record of commission's test well near Jericho.*

	Feet.
Pleistocene:	
1. Dark sandy loam	0– 1
2. Yellow clayey sand	4 – 5
3–6. Yellowish-brown fine to coarse glacial sand	8 –18
7. Yellowish-white coarse to fine gravel (doubtfully glacial)	18. 5–19. 5
8. Fine to medium yellowish-brown sand	23 –23. 5
9–10. Yellowish-white medium to coarse sand	28. 5–35. 5
11. Fine reddish-brown sand with considerable muscovite	39 –40
12–13. Medium to coarse yellowish-white sand with some biotite	44 –50
Cretaceous?:	
14–15. Fine to medium yellowish-white sand	54 –56
16. Very fine reddish-white sand	59 –60

514. *Record of H. R. Winthrop's well near Jericho.*

	Feet.
1. Surface loam	1– 6
Pleistocene and Cretaceous:	
2. Coarse sand and gravel	6–183

No change in the material from 6 to 183 feet. It was all of the same degree of fineness. Water was first encountered at 150 feet; down to that depth the material was almost perfectly dry. Four samples from the well, ranging from 171 feet 9 inches to 182 feet 10 inches, show very light-yellow sand and gravel, with no erratic material. It is therefore impossible to tell how much of this section is to be considered Pleistocene and how much pre-Pleistocene.

515. *Record of T. Willis's well near Jericho.*

	Feet.
Wisconsin:	
1. Ordinary sand with an occasional bowlder (several blasts were necessary)	0– 50
Mannetto? and Cretaceous:	
2. Quicksand	50– 53
3. Red sand, with alternate layers of yellow and reddish-yellow gravels	53–175. 5

See record and sample from well No. 514, which indicate that part of this gravel should be considered pre-Pleistocene.

516. The following record has been compiled from information furnished by Mr. John J. Hicks and Mr. William C. Jaegle:

Record of Jacob Jackson's well near Jericho.

	Feet.
Pleistocene:	
1. Surface sand and gravel	0– 40
Cretaceous:	
2. Black sticky clay, containing lignitized wood	40– 80
3. Sand, clay, and gravel	80–165
4. Sand (3-inch pipe)	165–168

Mr. Hicks reports that this well was drilled from 165 to 210 feet by A. W. Gallienne. Mr. Jaegle, however, drove a new pipe in the same well to a depth of 3 feet and found good water, so the Gallienne well is to be discounted.

517. Samples from this well, together with a section drawn by W. Goold Levison December 28, 1881, are preserved in the museum of the Long Island Historical Society.

In the following section the record given on the left is from Mr. Levison's drawing, and that on the right is from the samples:

Records of Jules Kunz's well near Jericho.

	Drawing.	Feet.	Samples.
Wisconsin	1. Clay and gravel loam	0 – 15	Yellow quartz sand and gravel.
	2. Compact, tough, unmodified drift.	15 – 51	No sample.
Mannetto?	3. Gravel and sand; "glacial rubble".	51 – 81	Fine sand to medium yellow gravel (all quartz).
Cretaceous	4. Sharp, yellow, friable sand	81 – 96	Yellow silty sand (Cretaceous?).
	5. Sandy clay; laminated; piece of tree (probably chestnut).	96 –103	Finely laminated yellow and white clay.
	6. Blue and gray, compact, sandy, rather tough clay, abounding in nodules and crusts of iron pyrites.	103 –133	Very dark, laminated, micaceous sandy clay, showing ripple marks ("blue clay").
	7. Micaceous sand; water; gray sand; fine dune sand.	133 –143	Fine, pink, clayey sand.
	8. Medium, white, micaceous sand	143. 5–147. 5	Do.

Merrill[a] and Darton[b] have both published records of this well in which an error has evidently been made in copying in the thickness of the yellow gravel, which extends from 51 to 81 feet.

518. This is a dug well from which the supply is now obtained from four 3-inch strainers 12 feet long, placed horizontally in the water-bearing gravel just above the clay, and connected directly with the suction pipe from the pump.

[a] Annals N. Y. Acad. Sci., vol. 3, 1886, p. 353.

[b] Bull. U. S. Geological Survey No. 138, p. 35.

Record of Allard & McGuire's well near Syosset.

	Feet.
Pleistocene:	
1. Sand and gravel	0–47
2. Gravel	47–50
Cretaceous:	
3. Lead-colored clay	50–53

519. Mr. Jaegle states that in sinking this well he encountered, at a depth of 150 feet, a stratum of fine gravel, overlaid by gravelly clay, from which the air rushed with considerable force. This is probably a blowing well similar to those which have been described in many parts of the West (see p. 74).

520. *Record of county poor farm well near Brookville.*

	Feet.
1. White sand and gravel	0–105
2. Quicksand; fine dark-colored sand with coarse material at bottom	105–278

521. *Record of H. Rushmore's well near Brookville.*

	Feet.
1. Surface loam and then ordinary sand	0– 75
2. Quicksand	75–375
3. Blue clay	375–377
4. Hardpan (gravel and sand packed very hard)	377–396

This record was reported by Mr. J. L. Bogart, who lives on the adjoining property and who was much interested in the well at the time it was sunk.

522. *Record of commission's well near East Norwich.*

	Feet.
Wisconsin:	
1. Dark surface loam and gravel	1 – 5
2–3. Reddish-yellow medium sand	4. 5– 7
4. Yellowish-gray clayey sand	12. 5–13. 8
5–6. Grayish sand and gravel (glacial)	14. 2–20
Wisconsin?:	
7. Light yellowish-white silt to coarse sand	20 –23

523. *Record of Quinan well near East Norwich.*

	Feet.
Wisconsin and Tisbury:	
1. Very stony sand and gravel	0–100
Tisbury and Cretaceous:	
2. Yellowish-red sand	100–120
Cretaceous:	
3. Black clay, becoming white	120–124
4. Clay and fine sand, dark colored	124–127
5. Coarse sand (water bearing)	127–149
6. Clay	149–

524. *Record of Ludlum well near East Norwich.*

	Feet.
1. Gravel	0–212
2. Sand	212–224
3. Clay	224–

525. The first test well at this place, which was put down about 25 feet from the engine house, was unsuccessful. The samples preserved in the office of Mr. Oscar Darling, consulting engineer, show the following section:

Record of Nassau County Water Company's well at Oyster Bay.

	Feet.
Pleistocene:	
1. White sand and gravel	0– 5
2. Coarse gravel	5– 15
3. Medium yellow sand	15– 60
4. Gray sand with much biotite	60–160

Water was found in abundance in the coarse gravel from 5 to 15 feet, but the sand below this point while water bearing, was regarded as too fine to furnish water for waterworks purposes. An attempt was then made to develop the stratum at 10 feet by a series of gang wells, but it was found to be only a small pocket. About 300 feet north of the pumping station, and down the valley, coarse water-bearing gravel was found at a depth of 10 feet which had a thickness of from 10 to 30 feet. It is expected that a gang of twelve 4-inch wells of an average depth of 35 feet will be put down at this point. The water from these wells stands just level with the surface, which is 23.5 feet above mean high tide.

526. This well was driven in 1900. At a depth of 3 or 4 feet from the surface clay was encountered, below which there was gravel, and then clay to a depth of 50 feet, where water was encountered which flowed 8 to 9 gallons per minute. Below this was sand and gravel, which furnished a small flow of artesian water, to a depth of 160 feet, where a layer of clay 2 feet thick was encountered. At 62 feet a strong artesian head was encountered which forced the water 11 inches above the 3-inch pipe, and furnished over 100 gallons per minute. As the water did not clear, it was driven through clay and sand to 165 feet, where it was stopped in sand and gravel. At this point it furnished about 80 gallons per minute of clear water. At 17 feet above the surface of the ground the well delivers 5 gallons per minute.

The following partial analysis was made by Prof. C. S. Slichter:

Analysis of water from Townsend Underhill's well near Oyster Bay.

	Parts per million.
Hardness	31.2
Chlorine	7.08
Alkalinity	27.5

Temperature, 59° F.

527. This well was driven in 1900 and now furnishes 15 gallons per minute at a height of 3 feet above the ground. The well is about 20 feet above mean sea level.

Record of Charles Weeks's well near Oyster Bay.

	Feet.
Wisconsin and Tisbury:	
1. Sand and gravel	0– 15
Sankaty?:	
2. Clay	15– 90
Jameco?:	
3. Micaceous sand, gradually growing coarser	90–110

528. *Record of J. M. Sammis's well near Oyster Bay.*

	Feet.
Wisconsin and Tisbury:	
1. Sand and gravel with poor water	0– 30
Sankaty?:	
2. Clay	30– 35
Cretaceous?:	
3. Fine white sand with little water	35–140

See fig. 16.

529. Mr. E. K. Hutchinson, under date of April 29, 1896, gives the following data regarding this well:

Record of well of Van Sise & Co. near Oyster Bay.

	Feet.
Wisconsin and Tisbury:	
1. Sand and gravel	0–30
Sankaty?:	
2. Clay	30–35
3. Clay and sand no water	35–53
Jameco?:	
4. Yellow sand and gravel	53–57

Flows 9 gallons per minute.

The flow of this well was measured by W. H. C. Pynchon, April 11, 1903, and found to be 3 gallons per minute, at a height of 18 inches above the surface, or 10 to 12 feet above mean sea level (see fig. 16).

530. On April 27, 1903, Mr. Pynchon found the flow to be 5 gallons per minute from a reduced nozzle at 18 inches above the surface. He reports that the water will rise 2½ feet above the surface.

Record of D. W. Smith's well at Oyster Bay.

	Feet.
Wisconsin and Tisbury:	
1. Sand and gravel	0–35
Sankaty?:	
2. Clay	35–50
Jameco?:	
3. Fine yellow sand, growing coarser	50–65

531. Mr. Hutchinson states that the original flow was 15 gallons per minute. On May 27, 1903, Mr. Pynchon found it to be 8.5 gallons. The water will rise about 6 feet above the surface of the ground.

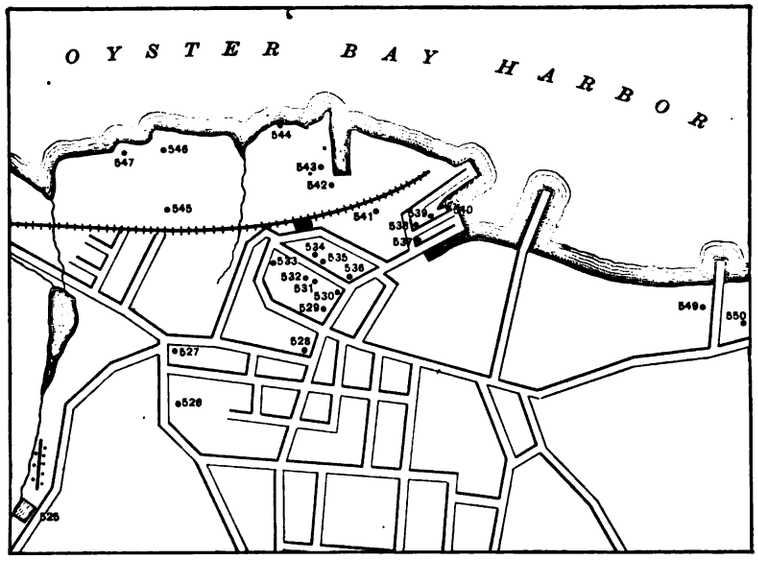

FIG. 67.—Sketch map showing locations of wells described at Oyster Bay.

532. The water-bearing gravel is reported to be unusually coarse in this well. When first completed, it flowed 21 gallons per minute.

Record of E. K. Hutchinson's well at Oyster Bay.

	Feet.
Wisconsin and Tisbury:	
1. Sand and gravel	0–35
Sankaty?:	
2. Clay	35–50
Jameco?:	
3. Sand, growing coarser	50–83

533. The clay layer usually encountered in this vicinity is reported as very thin in this well.

534. The original flow is reported as 10 gallons per minute. When measured by Mr. Pynchon April 27, 1903, it was 4 gallons per minute at a height of 2 feet above the surface.

535. The original flow was 9 to 10 gallons per minute. The flow April 27, 1903, was 2 gallons per minute at a height of 2 feet and 4 inches above the surface.

539. The following section of this well was furnished by Mr. E. K. Hutchinson in a letter dated April 29, 1895:

Record of A. J. & A. S. Hutchinson well at Oyster Bay.

	Feet.
Wisconsin and Tisbury:	
1. Sand and gravel, with plenty of water of poor quality	0– 30
2. Clay	30– 35
3. Sand and gravel; plenty of water raised 6 feet above level of first water	35–120
Sankaty(?):	
4. Clay; no water	120–185
Jameco?:	
5. Yellow sand and gravel with artesian water	185–190

The original flow from stratum 5 was about 70 gallons per minute at 3 feet above the ground. The water will rise to a point 17 feet above the surface at low tide and will overflow at high tide. The surface is 2 to 3 feet above mean high tide.

542. Mr. W. H. C. Pynchon reports the following history of this well:

"First position: Driven to a depth of 106 feet through sand and gravel with water all the way for 80 feet, then clay to 105 feet. It was left on Saturday night with water just dripping from the well pipe which stood 2 feet above ground. The flow kept on increasing until at the end of eight days it was flowing 50 gallons a minute from 2-inch pipe, about as much sand as water. It ran so for one week and then began to fall off, until at the end of one week more it was not running at all. Second position: It was then driven to 130 feet, but no flow Pipe was pulled up and its lower 6 feet perforated and covered with 40-mesh wire gauze. Third position: The pipe was then reinserted in the hole to a depth of about 125 feet, with the result that the water came up on the outside of the pipe instead of the inside so that earth had to be rammed in all around the pipe. It then flowed 18 gallons per minute at 3 feet above the surface, though the water will rise to a level of about 9 feet. The wellhead is now 3.50 feet above high tide." (For general relations see fig. 16.)

543. The flow at low tide, June 30, 1903, was 26.5 gallons per minute.

Record of Dr. O. L. Jones's well at Oyster Bay.

	Feet.
Wisconsin and Tisbury:	
1. Gravel	0– 60
Sankaty?:	
2. Clay	60–135
Jameco?:	
3. Little flow at	135–140
4. Coarse sand	140–
Cretaceous:	
5. Clay	
6. Very heavy gravel mixed with white sticky clay	–220

Prof. C. S. Slichter has made the following partial analysis of this water:

Analysis of water from Dr. O. L. Jones's well at Oyster Bay.

	Parts per million.
Hardness	20.0
Chlorine	4.25
Alkalinity	17.0
Temperature	57° F.

544. "Driven in July, 1896. It is located on the beach at the edge of the salt marsh, and the tide rises ordinarily about 1 foot over the wellhead, i. e., well is about 6 feet above low-tide mark. At low tide the flow is not over 20 gallons per minute, but just before the tide goes over the wellhead it flows 100 gallons a minute. Water comes from gray and black sand, but is free from iron."

This well was sounded in connection with observations on the effect of the tide on the rate of flow and found to be 93.1 feet deep. (For general relations see fig. 16.)

The sample of water, marked Mohannes Spring, Oyster Bay, Long Island, submitted to me for examination contains:

Analysis of water from Mohannes Casino well at Oyster Bay.

	Parts per million.
Appearance	Clear.
Sediment	None.
Color	None.
Odor (heated to 100° F)	None.
Chlorine in chlorides	7.92
Sodium chloride	13.08
Phosphates	None.
Nitrogen in nitrites	None.
Nitrogen in nitrates (reduced by sodium amalgam)	.495
Free ammonia	Trace.
Albuminoid ammonia	Trace.
Total nitrogen	.495
Total hardness	28.3
Permanent hardness	28.3
Organic and volatile (loss on ignition)	8.00
Mineral matter (nonvolatile)	46.00
Total solids (by evaporation)	54.00

This sample of water is of great organic purity; it is very soft and is admirably adapted for use as a drinking water as well as for domestic purposes.—*Ernst J. Lederle, Ph. D.*

The "Mohannes Spring" is the 99-foot artesian well described in the table of wells.

545. The water is so strongly impregnated with iron that it is unfit to drink. Yield 2 feet above the ground, 18 gallons per minute, at high tide.

Record of T. Underhill's well at Oyster Bay.

	Feet.
Recent to Tisbury:	
1. Sand and gravel	0– 25
Sankaty:	
2. Clay	25– 80
Jameco:	
3. Fine gray and black sand, growing coarser	80–107

Total depth according to sounding, 114 feet.

Analysis of water from T. Underhill's well at Oyster Bay.

[By Prof. C. S. Slichter.]

	Parts per million.
Hardness	46.9
Chlorine	6.18
Alkalinity	37.5
Temperature	57° F.

546. *Record of Lee well at Oyster Bay.*

	Feet.
1. Heavy sand and gravel	0– 50
2. Gray and blue clay	50–125
3. Beach sand, growing coarser, well commenced to flow at 160 feet	130–200

Depth by sounding, 188.3 feet.

Analysis of water from Lee well at Oyster Bay.

[By Prof. C. S. Slichter.]

	Parts per million.
Hardness	37.0
Chlorine	3.9
Alkalinity	43.7
Temperature	58 F°.

547. *Analysis of water from Burgess well at Oyster Bay.*

[By Prof. C. S. Slichter.]

	Parts per million.
Hardness	28.7
Chlorine	4.77
Temperature	58° F.

See Pl. XIII, *A*.

548. *Record of Hamilton well near Oyster Bay.*

	Feet.
Wisconsin and Tisbury:	
1. Gravel	0– 30
Sankaty?:	
2. Clay	30– 80
Jameco?:	
3. Sand with water, not artesian	80–130
Cretaceous:	
4. Clay	130–227

A second well was drilled near this one and a good flow obtained at 105 feet.

549. *Record of William Trotter's well near Oyster Bay.*

	Feet.
Wisconsin and Tisbury:	
1. Gravel	0–10
Sankaty?:	
2. Clay	10–70
Jameco?:	
3. Gravel, with artesian water	70–90

Analysis of water from William Trotter's well near Oyster Bay.

[By Prof. C. S. Slichter.]

	Parts per million.
Hardness	21.9
Chlorine	6.2
Alkalinity	21.0
Temperature	56° F.

551. Water is reported for the whole depth of the well, but did not flow until a depth of 259 feet was reached.

Record of H. Dollard's well near Oyster Bay.

	Feet.
1. Surface sand and gravel with some water	0– 45
2. Fine dark-colored brown sand, becoming coarser at the bottom and passing into a lead-colored gravel	45–259

Analysis of water from H. Dollard's well near Oyster Bay.

[By Prof. C. S. Slichter.]

	Parts per million.
Hardness	33.7
Chlorine	6.02
Alkalinity	19.95
Temperature	62° F.

552. The following section is from Mr. Ed. Schmidt:

Record of Edward Swan's well near Oyster Bay.

	Feet.
1. Coarse sand, slightly yellow in color, with occasional layer of gravel	0–60

553. This well was very easily drilled. The material became coarser and coarser until at 465 feet an excellent flow was obtained. There was no red clay here and no hard red stratum. A little blue clay was found at 150 feet.

Record of E. Roosevelt's well near Oyster Bay.

	Feet.
Wisconsin and Tisbury:	
1. Sand and gravel, water bearing	0–100
Cretaceous:	
2. Brown sandy clay, grading into gray sandy clay	100–465

554. For partial analysis see page 68. (See fig. 16 for general relations.)

555. *Record of G. M. Fletcher's well on Center Island, New York.*

	Feet.
Pleistocene and Cretaceous?:	
1. Sand, with an occasional stratum of clay	0–160
Cretaceous:	
2. Alternate layers of yellow, black, red, blue (hard like flint), and milky-white clay	160 –316
3. Very fine beach sand	316 –330
4. Thin stratum of brown shale	330 –330.4
5. Coarse sand (with some water)	330.4–360
6. Thin stratum of brown shale	360 –360.2
7. Very fine sand, gradually growing coarser	360.2–370.10

Elevation above tide 12 feet.

At the last depth given the particles ranged from one-eighth to one-half inch in diameter. A concretion was encountered at 280 feet, and lignite at 330, 350, and 370 feet.

Mr. Frank Nichols, foreman in charge of the drilling of this well, reports that salt water was encountered at 18 feet and again at 100 feet. Fresh water was first encountered at 360 feet.

556. For partial analysis see page 68.

557. Nichols states that the natural pressure is "lower" in this well than in the others, and this, together with the fact that salt water was used in drilling the well, necessitated long pumping before the water became fresh. The clay contains a great deal of sand and is very micaceous.

The low pressure is probably due to the fact that the main artesian gravel was not reached. It will be noticed on Pl. II that this well lacks 50 feet of reaching the coarse Lloyd gravel, in which the other wells are finished.

Record of S. T. Shaw's well on Center Island, New York.

	Feet.
Pleistocene:	
1. Coarse yellow gravel	0– 50
Pleistocene and Cretaceous:	
2. Fine beach sand and clay	50–150
Cretaceous:	
3. White, blue, and gray clay; red clay and sand and gray clay; encountered in the order named	150–295
4. Coarse sand	295–298

558. Mr. R. F. Nichols, foreman in charge of the drilling of this well, reports the following section:

Record of C. Hoyt's well on Center Island, New York.

	Feet.
Pleistocene:	
1. Very coarse gravel, coarse as black walnuts	0– 60
Cretaceous:	
2. White and very sticky clay	60– 72
3. White beach sand	72– 90
4. "Very pretty blue" clay	90–130
5. Gray sandy clay	130–275

Cretaceous:	Feet.
6. Very hard stratum, brownish red in color, were two days in drilling 8 inches; described as very similar to hard stratum reported in Fletcher well (No. 555)	275–
7. Gray sandy clay	
8. A second hard stratum	–300
9. Sand, becoming coarser and passing into white gravel-like peas	300–321

Well began to flow at 300 feet. Elevation above mean high tide, 4 feet.

559. Mr. R. F. Nichols, foreman, reports that this well began to flow at night. The screen was put in and the well was left at the depth to which it had been sunk.

Record of C. W. Wetmore's well on Center Island, New York.

Pleistocene:	Feet.
1. Sand and gravel	0– 60
Cretaceous:	
2. Clay, no bowlders	60–300
3. Very white sand (Lloyd sand)	300–318

Elevation above mean high tide, 3 feet.

For partial analysis, see page 68.

560. The material encountered in this well is very similar to that found in No. 558. Below 150 feet considerable lignite was found.

562. Mr. A. Neilson, superintendent of the Pierce estate, reports the following: "The writer was not managing the property when the well was put down, and so can not give record of strata. There was originally an old open well 30 feet deep, which was a good one, but to get more water a 6-inch pipe was put down 10 feet below the bottom of the open well. This well is about 600 feet back from the shore of the sound, and the top is about 30 feet above high water. The tides do not change the water in any way. About 150 feet from the one described there is another well about 80 feet deep, all 6-inch pipe, which I believe is a better well, though it has never been tested to its full capacity."

Mr. Frank Wankel, now foreman of the Hudson Engineering and Contracting Company, reports that a number of years ago he sunk a 6-inch well for Colonel Kruger, and it may be that this is the well referred to in the above letter. Mr. Wankel gives the following data regarding it:

Record of Colonel Kruger's well near Bayville.

Wisconsin and Tisbury:	Feet.
1. Beach sand	0–160
2. Coarse gravel	160–170

At this depth a fine material was encountered and the driving was discontinued. No clay was encountered. The well is 200 feet from the water's edge, and 50 or 60 feet above sea level, and tests 15 gallons a minute at full capacity.

564. Mr. Danis stated that early in July, 1903, the pipe, which originally extended 9 feet above the surface, was cut off even with the ground, and the flow increased very rapidly from 75 to 120 gallons per minute, weir measurement. Sand then followed and the water finally became very red. After a time it cleared and continued to flow at the increased rate.

Record of I. Cox's well near Mill Neck.

Tisbury:	Feet.
1. White sand with fresh water	0– 12
2. White sand with very salty water	12–100
Sankaty?:	
3. "Black muck"	100–150
Cretaceous:	
4. Thin layers of clay and quicksand	150–200
5. Red clay, with occasional layers of gray clay containing lignitized wood	200–300
6. Sand, becoming coarser and filled with water (Lloyd sand)	300–330

566. *Record of commission's test well at Massapequa pumping station.*

	Feet.
1–2. Peat with sand and gravel	0– 2
3–4. Dark-brown vegetable stained sand and gravel	2– 5
5–9. Yellow-brown sand and gravel (probably glacial outwash)	5–24

567. According to Mr. Ward this plant consists of fifty-three 4½-inch wells, 37 to 106 feet deep. All the deeper wells furnish artesian water. Samples of the shallower wells, preserved in the municipal building, Brooklyn, show the following generalized section:

Generalized section of Brooklyn waterworks wells at Massapequa pumping station.

	Feet.
1. Light yellowish gray sand and gravel; nothing readily recognizable as of glacial origin.	0–25
2. Fine reddish brown to yellowish gray sand	25–40
3. Fine gray sand	40–

The elevation of deep test well No. 1, which is a flowing well, is 10.1 feet Brooklyn base.

568. Mr. Solomon Ketchem, secretary, reports that the supply of the Amityville Water Company is derived from 6-inch wells, 40 feet deep, sunk in 1893; the water level is 12 feet below the surface and is lowered 4 feet by pumping. The yield in 1900 was as follows:

Yield of Amityville Water Company's wells in 1900.

	Gallons.
Maximum daily	156,000
Minimum daily	53,000
Average daily	104,000

569. The whole section given below is glacial outwash.

Record of commission's well near Massapequa pumping station.

	Feet.
1–2. Yellow sandy loam	0–2.4
3–9. Fine reddish-yellow sand to small gravel	4.5–31

See Table XII.

570. *Record of commission's well near Massapequa pumping station.*

	Feet.
1. Humus-stained loamy sand and gravel	0.0– 0.4
2–3. Reddish-yellow loamy sand and gravel	1.0– 3.5
4–6. Light yellowish-white outwash sand and gravel	6.0–17.75

571. *Record of commission's well near Massapequa pumping station.*

	Feet.
1–3. Surface loam	0– 2
3–9. Light-colored sand and quartz gravel only a very small percentage of erratic material.	5–31

572. *Record of commission's well near Massapequa pumping station.*

	Feet.
1–2. Surface loam	0– 1.2
3–9. Light grayish sand and small gravel, with a smaller percentage of erratics than in the wells farther west	5–35.5

573. *Record of commission's well near Massapequa pumping station.*

	Feet.
1–2. Yellow sandy loam	0– 1.5
3–7. Reddish yellow fine to coarse sand (glacial outwash)	4–25

574. *Record of commission's well near Massapequa pumping station.*

Wisconsin:	Feet.
1–2. Surface loam	0 – 2.3
3. Yellow loamy sand and gravel	2.7– 3.3
4–9. Coarse outwash sand and gravel	5 –32

	Feet.	
Tisbury:		
10. Fine yellowish gray sand	36	–36.5
11. Very fine yellowish gray sand	37.5	–38
12. Medium sand	40	–41
13. Fine to coarse sand	45	–46
14–15. Coarse sand to fine gravel, with small layer of silt	50.5	–53
16–18. Fine silty sand	55	–61.5
19. Fine to medium sand	63	–64
20. Coarse sand	65.5	–66.5
21. Fine silty sand	70	–72.5
Cretaceous:		
22. Very fine, greenish yellow, micaceous sand	74.5	–75.5
23–24. Medium, white, coarse sand	80	–85

This series of samples shows apparently four stages of deposition above a depth of 70 feet. See Table XII.

575. *Record of commission's well near Massapequa pumping station.*

	Feet.	
Wisconsin and Tisbury?:		
1. Surface loam	0	– 1
2–3. Yellow sand and small gravel	1.5	– 4
4–5. Yellowish white sand and small gravel	6	–11
6. Small gravel, with considerable percentage of erratics	15	–16
7. Fine to coarse sand	20	–21
Cretaceous?:		
8–12. Fine white sand with tendency toward a yellow color in the upper samples, possibly due to an old land surface	24	–41.5

See Table XII.

576. *Record of Dryfuss & Nibbe's well near Central Park.*

	Feet.	
Pleistocene:		
1. Surface gravel	0	–15
Cretaceous:		
2. Black clay	15	–35
3. Iron rock	35	–35.5
4. Fine dark sand, becoming coarser and containing water	35.5	–55

Mr. J. Elliott reports having dug a well at this place in which he struck clay very near the surface and passed through 3 feet of iron rock.

Analysis of water from Dryfuss & Nibbe's well near Central Park.

[By Prof. C. S. Slichter.]

	Parts per million.
Hardness	185
Chlorine	55.6
Alkalinity	26.2
Temperature	56–F.

The high hardness and chlorine indicates that this well has become contaminated with the brines from the pickle factory.

577. Mr. Elliott reports that in some of these wells thin layers of clay were found at 4 feet and 20 feet. He adds that similar layers of clay are often found in wells at a distance of half a mile from the foot of the hills, at which point the silty or clayey layers disappear.

578. The high chlorine in the analysis below is doubtless due to brine from the pickle factory.

Analysis of water from well of J. Keller & Sons near Farmingdale

[By Prof. C. S. Slichter.]

	Parts per million.
Hardness	30.6
Chlorine	32.6
Alkalinity	21.5
Temperature	63–F.

580. *Record of commission's test well near Farmingdale.*

	Feet.
1. Surface loam	0– 1
2–6. Light sands, passing into small gravel, with a very small percentage of erratics	1–21

582. Mr. J. H. Gutheil gives the following data: "Diameter, 3 feet from 0 to 81; 1¼ inches from 81 to 111 feet. The surface of the ground is black soil mixed with coarse gravel; yellow clay is underneath; then pure sand in depths of 10 to 15 feet, separated by iron ore and hardpan. About the middle of the distance in depth I found a coarse yellow sand, very sticky, as if mixed with mud."

583. *Record of Harms estate well near Plainview.*

	Feet.
Pleistocene:	
1. Gravel	0–50
Cretaceous:	
2. Alternate layers of light gray and black clay	50–70
3. Dark, rather coarse sand, with water	70–75

584. Mr. Elliott furnished four samples representing material between 58 and 70 feet; all are fine yellow Cretaceous (?) sand.

Analysis of water from John Titus's well near Plainview.

[By Prof. C. S. Slichter.]

	Parts per million.
Hardness	20
Chlorine	2.76
Alkalinity	9
Temperature	59° F.

585. *Record of Oscar Jackson's well in West Hills.*

	Feet.
Pleistocene:	
1. Dark surface soil mixed with large field stones	0– 2
Cretaceous:	
2. Clay	2– 6
3. Fine white sand	6– 16
4. Coarse gravel mixed with clay, parted by veins of iron ore and hardpan	16– 56
5. Sand with veins of black and blue clay 2 to 3 feet thick	56–119
6. Driven; material not known	119–141.5

586. Mr. Dubois has furnished the following samples from this well:

Record of H. L. Stimpson's well in the West Hills.

	Feet.
Wisconsin:	
1–3. Clayey sand and gravel with many compound pebbles	8– 20
Mannetto:	
4. Orange-yellow quartz pebbles, with a very few fragments of compound rocks, the latter probably derived from the overlying beds	28
5. Orange-yellow quartz pebbles, with considerable sand and yellow clay, and many fragments of decayed white chert	40
6. White quartz sand, with much fine-grained red ironstone and decayed chert	52

Cretaceous ?:	Feet.
7–17. White to light-yellow quartz sand and gravel containing fragments of decayed white chert	60–120
18. Fine to coarse reddish yellow sand	125
19. Fine to coarse white sand	130
20. Fine to coarse yellow sand	135
21–22. Medium, yellow, silty sand, with many small, brown, ferruginous nodules and a few pellets of clay	140–145
23–24. Medium to coarse light-yellow sand with many fragments of dark-brown ferruginous sandstone	150–155

587. *Record of Richard Collier's well near Woodbury.*

Pleistocene:	Feet.
1. Surface loam; no gravel	0– 15
2. Sand with considerable gravel	15– 35
3. Gravel	35– 98
Cretaceous:	
4. Black clay	98–138
5. Hard iron rock	138–138.5
6. White sand	138.5–144

Analysis of water from Richard Collier's well near Woodbury.

[By Prof. C. S. Slichter.]

	Parts per million.
Hardness	52.5
Chlorine	16.6
Alkalinity	12.5
Temperature	60° F.

588. Mr. William Jaegle, who drilled this well, reports that between 120 and 150 feet he encountered a dry gravel from which the air rushed with considerable force, and that it blows intermittently between the 4-inch and 6-inch casing. The 6-inch casing extends to a depth of 120 feet and the 4-inch to a depth of 185 feet.

589. Mr. William Jaegle reports that a blowing well formerly existed at this place, but that it was destroyed in an attempt to find the hidden treasure which this blowing was thought to indicate.

590. It is stated that this well blows before a storm, and that it makes enough noise to be heard in the house.

591. These samples were taken from the dump by one of the men who had been with the well from the start. The surface about the well is distinctly moraina1 in character, but the samples indicate that the Pleistocene material is of no very great thickness. The sands are apparently the same as the sands shown in the Melville section.

Record of Cold Spring Creamery well near Cold Spring station,.

Cretaceous:	Feet.
1. Dark clayey sands	0–20
2. Medium yellow sand	20–60
3. Medium reddish yellow sand, containing water	60–96

592. *Record of H. A. Monfort's well near Cold Spring station.*

Wisconsin:	Feet.
1. Loam and gravel	0– 4
Wisconsin and Cretaceous:	
2. White sand (dry)	4– 90
Cretaceous:	
3. Dark clay	90–130
4. Orange clayey sand	130–173
5. Blue clay	173–181
6. White sand	181–195

593. *Analysis of water from Mountain Mist Springs, West Hills.*

[By G. J. Volckening, E. M., Feb. 21, 1898.]

	Parts per million.
Sodium chloride	13.95
Lime	6.80
Magnesia	2.15
Iron and alumina	.41
Sulphuric anhydride	2.53
Carbonic anhydride	5.15
Silica	8.17
Alkalies (approximate)	1.00
Total	40.16

594. The section in this well is reported as very similar to that of well No. 595.

595. *Record of Columbia farm well near Cold Spring Harbor.*

	Feet.
Wisconsin and Tisbury:	
1. Sands and gravel.	
Cretaceous:	
2. Water-bearing sand, yielding milky water at	186
3. Alternate layers of fine white or lead-colored clay and sands, the sands containing water	186–195

596. At 160 feet the well is reported to have furnished quite a little gas, which has very much the odor of marsh gas.

Record of W. R. Jones's well near Cold Spring Harbor.

	Feet.
Tisbury:	
1. Sand and gravel	0–190
Cretaceous:	
2. Black clay, becoming whiter below	190–200
3. White sand with water	200–228

598. *Record of Mrs. W. Wood's well near Cold Spring Harbor.*

	Feet.
Tisbury:	
1. Sand and gravel with an abundant supply of clear water, which turned dark on boiling	0– 40
Cretaceous:	
2. Alternate layers of white or lead-colored sands and clays	40–163

599. *Record of well of Van Wyke heirs near Cold Spring Harbor.*

	Feet.
Tisbury:	
1. Surface sand and gravel	0– 35
2. Sand and gravel, with a little water	35– 40
Cretaceous:	
3. Sand and clay	40–150
4. Water-bearing sand	150–

601. *Record of W. E. Jones's well near Cold Spring Harbor.*

	Feet.
Pleistocene:	
1. Sand	0–160
2. Clayey sand	160–179
3. Gravel with glacial pebbles	179–195

602. This is stated to be the well which in Darton's report is given as "Cold Spring Harbor, 125 feet deep; flow 18 gallons per minute."

603. *Record of G. E. Brightson's well near Cold Spring Harbor.*

	Feet.
1. Gravelly clay, quite hard	0– 30
2. Fine gravel and coarse sand	30–105
3. Blue clay	105–135
4. Bluish sand	135–170
5. Very coarse sand, water bearing	170–177

604. *Record of L. C. Tiffany's well near Cold Spring Harbor.*

	Feet.
Tisbury:	
1. Gravel	0–125
Cretaceous?:	
2. Clay, with some grit	125–135
3. Fine sand	135–225
4. Blue clay	225–235
5. Coarse sand, with abundant supply of water	235–243

607. *Record of Wm. White's well near Cold Spring Harbor.*

	Feet.
Tisbury:	
1. Sand and gravel	0– 40
Cretaceous?:	
2. Black clay	40– 41
3. Sand and gravel	41– 95
4. Brown clay, passing below into white clay	95–118
5. Red sand	118–120
6. Fine white sand	120–179

The well began to flow at 120 feet, but choked with sand, and a free flow was not obtained until a depth of 179 feet was reached. This well flowed 12 feet above high tide.

608. *Record of J. T. Jones's well near Cold Spring Harbor.*

	Feet.
Tisbury:	
1. Top soil and gravel, with highly mineral water	0–12
Tisbury?:	
2. Black muck	12–20
3. Coarse sand and gravel	20–60
Cretaceous:	
4. White clay	60–65
5. Red sand	65–66
6. Coarse white sand, with artesian water	66–70

609. *Record of L. C. Tiffany's well near Cold Spring Harbor.*

	Feet.
Tisbury:	
1. Marly mud	0– 5
2. Beach gravel, with large stones	5–50
Cretaceous?:	
3. Clay, black on top, becoming white below	50–58
4. Fine sand, becoming coarser below	58–76.8

When the artesian sand was first struck, it is estimated that the well flowed 120 gallons per minute, but the water contained a large amount of fine, white, micaceous sand. To cut off this, the well was driven deeper and the flow reduced to 75 gallons per minute (measured). This is the maximum yield, the flow being less at low tide.

610. *Record of H. De Forest's well near Cold Spring Harbor.*

	Feet.
Tisbury:	
1. Upper gravel and sand	0– 80
Cretaceous:	
2. White clay	80 – 80.5
3. Orange sand	80.5– 95
4. Sand, brighter yellow than No. 3	95 –133
5. White clay	133 –148
6. Fine sand becoming coarser	148 –165

612. The following record has been prepared from samples preserved from this well:

Record of R. De Forest's well near Cold Spring Harbor.

	Feet.
Wisconsin:	
1. Glacial sand and clay	5
2. Large quartz and granite pebbles	15
Cretaceous:	
3. Medium light-yellow sand	17– 25
4. Pink sand, medium	28.8
5. Medium, white, quartz sand with much mica	32
6. Fine pink sand	60
7. Medium, coarse, white, quartz sand	70
8. Coarse quartz with large pieces of FeS	120
9. White laminated clay	160–167
10. Fine gravel; water bearing	177–183.8

613. *Record of Eagle dock well near Cold Spring Harbor.*

	Feet.
Recent:	
1. Filled ground	0– 10
2. Muck	10– 14
Tisbury:	
3. Beach gravel with salty water	14–100
Sankaty:	
4. Clay	100–158
Jameco:	
5. Fine sand, passing into coarse gravel containing artesian water	158–176

The samples of the water-bearing gravel preserved by Capt. W. R. Bingham show a very large percentage of erratic material.

614. Mr. Webster reports that the measured flow of this well at 12.10 p. m., December 31, 1902, was 39 gallons per minute. Mr. J. G. Hannah, the former owner of the well, reports that on November 5, 1902, the flow at low tide was 16 gallons per minute and at high tide 50 gallons per minute. Mr. Webster has kindly furnished the following analysis, and notes by Prof. Herbert E. Smith, State chemist of Connecticut:

Analysis of water from James Bowen's well near Cold Spring Harbor.

	Parts per million.
Residue on evaporation:	
Total	39.0
Volatile	13.5
Chlorine, combined	4.00
Nitrogen of free ammonia	.032
Nitrogen of albuminoid ammonia	.012
Nitrogen of nitrites	.001
Nitrogen of nitrates	.55
Oxygen consumed from permanganate in one-half hour at 100° C	.2
Hardness as carbonate of calcium	10.00
Color	0.0

Professor Smith says: "The sample was clear, free from sediment, colorless, and odorless. These results show that the water contains a very small amount of mineral matter, that it is soft, and that it is of high organic purity. The figure for chlorine is subnormal for the locality of the well, and the nitrogen of nitrates is not much, if any, above the normal. These results indicate, in my opinion, that the water is free from sewage or drainage contamination and excellent for drinking and other domestic uses.

* * * * * * *

"The figures for organic matter are very satisfactory indeed. The figure for chlorine (4) is the chlorine that is normal to a narrow strip in the central portion of Long Island. According to the chlorine map, this area is about 35 miles long, with an average width of not over 2 miles, and runs through Suffolk County, back of Cold Spring Harbor. As the normal on the coast is 6 or above, the result in this sample would indicate that the water comes from the interior portion of the island.

"I of course do not wish to make too strict an interpretation of a single analysis, but where the difference between the local chlorine and that found is so distinct as in this case, I think it pretty safe to conclude that the water sent me comes from the interior."

In this connection see the analysis from the deep wells given on page 68 and analyses of wells Nos. 526, 543, 545, 546, 547, 549, 554, 556, and 559.

615. *Record of L. V. Bell's well near Cold Spring Harbor.*

	Feet.
1. Coarse sand and gravel, with one or two layers of cobbles; no clay	0–65

616. This well is in the basement and begins in pink Cretaceous sand.

617. Mr. Matthew King, foreman for P. H. & J. Conlan, reports that this well is 325 feet deep, but Mr. J. Conlan states that it was finished at 140 feet.

620. *Record of T. S. Williams's well near Cold Spring Harbor.*

	Feet.
Wisconsin:	
1. Gravel	0 – 30
Cretaceous:	
2. Red and white sand	30 – 80
3. White clay	80 – 86
4. Fine white sand; fresh water	86 –136
5. White clay and sand	136 –146
6. Yellow sand and gravel (looks like brown sugar)	146 –160
7. Red and white clay	160 –162
8. Fine white sand	162 –178
9. Coarse quartz gravel; no sand; gravel about 1 inch diameter	178 –200
10. Fine white sand becoming pinkish	200 –230
11. Small gravel	230 –230.5
12. White sand	230.5–256
13. Yellow clay	256 –257
14. Reddish sand	257 –262
15. Gray clay	262 –394
16. Coarse yellow gravel	394 –398

This well flows 10 gallons per minute at a height of 8.5 feet above mean high tide.

621. Mr. Danis reports the following section for this well:

Record of Walter Jennings's well near Cold Spring Harbor.

	Feet.
Wisconsin:	
1. Stony soil	0–10
Cretaceous:	
2. Clay	10–12
3. Sand	12–40
4. Clay	40–42
5. Red sand	42–65
6. White sand	65–92

622. This well was first driven 42 feet and water obtained which was used for a time, but proved unsatisfactory. It was then deepened and two more water-bearing sands encountered. The present supply from the lower layer is reported to be very good.

623. *Record of R. De Forest's well, West Neck.*

	Feet.
Cretaceous:	
1. Brownish-red sandy clay	0–117
2. White sand	117–137
3. Clay	137–157
4. Coarse white sand; water bearing	157–168

624. *Record of Alex. Denton's well near Huntington.*

	Feet.
Wisconsin:	
1. Hardpan	0– 80
Tisbury?:	
2. Fine white sand	80–165
Cretaceous:	
3. Light-colored clay	165–175
4. Water-bearing sand	175–181

625. *Record of H. J. Dubois's well near Huntington.*

	Feet.
Wisconsin and Tisbury:	
1. Gravel and sand	0– 80
Tisbury and Cretaceous:	
2. Very fine brown clayey sand	80–255
Cretaceous:	
3. Fine to coarse light-yellow sand	255–264

626. On May 11, 1903, gage readings were begun on this well. Observations for six hours showed no fluctuations in the level of the water, which rose about 10 inches above the top of the pipe out of which it was flowing before being piped up. Mr. Sammis says that when first driven the water did not reach the top of the pipe but stood several inches below it. After one or two weeks' pumping the well began to flow.

627. This well was all in sandy gravel, with the exception of a thin layer of clay just above the white water-bearing gravel.

628. This well was abandoned in the summer of 1903, but Mr. Dubois states that they intend to sink it deeper. It will be seen from Pl. XVI that the Lloyd gravel should be encountered at this place at about 500 feet below sea level, or about 125 feet below the present bottom of the well. The chances of getting a good supply of water by deepening the well 150 feet are, therefore, regarded as extremely good.

Record of B. Ward's well, West Neck.

	Feet.
Wisconsin:	
1. Loam	0– 10
Tisbury:	
2. Sand and gravel	10– 88
Sankaty?:	
3. Blue clay	88–116
Jameco?:	
4. Dark-brown gravel mixed with clay	116–149
Transition:	
5. Dark-brown sand	148–164
Cretaceous:	
6. Blue hardpan	164–173
7. Blue clay	173–193
8. Pink clay	193–273
9. Brown sand, very fine	273–280

Cretaceous—Continued.	Feet.
10. Pink clay	280–335
11. Pebbles	335–336
12. Dark-brown sandy clay	336–347
13. Sandstone	347–350
14. Pink clay	350–386
15. Brown sand	386–416
16. Fine sand, like quicksand	416–417
17. Brown clay	417–429
18. Water sand	429–430
19. Light-blue clay	430–432
20. Very black clay	432–435
21. Light-blue clay, turning to reddish color near bottom of stratum	435–439
22. Brick-red clay	439–444
23. Slate-colored clay	444–447
24. White clay, like kaolin	447–449
25. Very dark-blue clay	449–453
26. Blue clay with charcoal	453–455
27. Light-blue clay	455–461
28. Light-green clay	461–465
29. Red clay	465–471
30. Dark-gray clay	471–476
31. Light-blue clay	476–479
32. Dark-brown sand	479–480
33. Green clay	480–482
34. Red clay mixed with blue	482–485
35. Very fine brown sand mixed with clay	485–487
36. Very white clay	487–488
37. Black clay	488–491
38. Dark-brown clay	491–495
39. Drab-colored clay	495–497
40. Hardpan, or sand rock; looks like an oolitic limestone	497–498

629. *Record of Mrs. M. H. Clots's well, West Neck.*

Wisconsin and Tisbury:	Feet.
1. Surface loam	0–10
2. Hardpan with gravel	10–25
Tisbury and Sankaty:	
3. Fine brown sand; a little clay	25–85
Sankaty:	
4. Blue clay	85–93
Jameco?:	
5. Brown gravelly sand; water bearing	93–97

630. The 4-inch pipe is cut off 17 feet from surface, and the well flows 10 gallons per minute into an underground cistern. Water would rise to within 4 feet of the surface.

A 5-inch well was sunk about 10 feet from the 4-inch well, to a depth of 147 feet, and flows into the underground cistern 18 gallons per minute.

Record of A. Heckscher's well near Halesite.

Wisconsin:	Feet.
1. Surface	0– 10
Cretaceous:	
2. Pink clay	10–140
3. Coarse white gravel	140–142

631. *Record of Mrs. A. W. Marsh's well, West Neck.*

	Feet.
1. Dug well	0– 80
Cretaceous:	
2. Marl	80– 90
3. Blue clay	90–110
4. Fine sand, white	110–111
5. White clay	111–115
6. Water-bearing sand	115–131

632. *Record of R. B. Conklin's well, West Neck.*

	Feet.
Wisconsin:	
1. Surface earth	0 –10
2. Bowlders	10 –12.5
3. Gravel and clay mixed with surface material	12.5–24
Tisbury:	
4. Fine dark-gray sand	24 –29
5. Dark-gray gravel	29 –30
Cretaceous?:	
6. White sand	30 –46
7. White quartz gravel; water bearing	46 –51
8. Yellow sand	51 –56

633. This well was visited in company with Dr. O. L. Jones on April 24, 1903, and the following samples and records obtained. At this time the pipe had been cut off about a foot below the mean level of the ground (5 to 6 feet above high tide), and the well was flowing about 5 gallons per minute. The foreman stated that at low tide the water ceased to flow, but when the tide had risen 1 foot the well commenced to flow and the flow increased until high tide.

Record of Dr. O. L. Jones's well, Lloyd Neck.

	Feet.
Recent to Tisbury:	
1. Sand and gravel	0– 95
Sankaty?:	
2. Dark-gray laminated clay, with pieces of partly lignitized wood	95–105
Jameco?:	
3. Fine to coarse yellow sand (glacial?)	105–122
Cretaceous:	
4. Dark-gray laminated clay	122–222
Lloyd sand:	
5–6. Very light-yellow sand, with fragments of white, very much decayed chert	222–243
7. White quartz gravel, with a few pebbles of ferruginous sandstone and white chert	243–246
8. Coarse, light-yellow sand, with a few fossil fragments	247.5
9. Small yellow quartz gravel, with a few white chert pebbles	248.5

The fossils from No. 8 were submitted to Dr. T. W. Stanton and he regarded them as Upper Cretaceous. They show: (1) Crinoid stem; (2) fragment of shell; (3) *Clausa americana*, a bryozoan very common in the Rancocas formation in New Jersey. (Identified by Ray S. Bassler.)

635. *Record of commission's test well 1 mile northeast of Amityville.*

	Feet.
1–2. Surface loam	0– 1
3. Gravel and yellow loam	1– 2
4–8. White quartz, sand, and gravel; very few if any erratics	5–25

See Table XII.

636. *Record of commission's test well 1 mile north of Lindenhurst.*

	Feet
1. Very dark sandy clay	0 – 0.5
2–4. Sand and gravel, with a small percentage of erratics	0.5–16
5–6. Medium gray sand (possibly glacial)	16 –21

637. *Record of commission's test well 2 miles northwest of Lindenhurst.*

	Feet.
1–2. Surface loam and sand	0– 1
3–9. Sand and small gravel; very small percentage of erratics	1–29.5

See Table XII.

638. *Record of commission's test well near Maywood.*

	Feet.
1–2. Surface loam	0– 1
3–9. Light grayish-white sand and quartz gravel; very small percentage of erratics	5–30

639. *Record of commission's test well 1.5 miles south of Pinelawn.*

	Feet.	
Wisconsin and Tisbury:		
1. Dark-colored loamy sand	0	– 0.5
2–5. Dirty yellow sand and small gravel		.5–16
6–7. White sand and gravel; some erratics	20	–26
8. Fine yellow sand	30	–35
9–14. Medium grayish-yellow sand; some erratics	40	–60.
Cretaceous:		
15–19. Coarse, sharp yellowish-white sand	60	–85
20–21. Very dark, fine lignitic sand	87	–92

See Table XII.

640. *Record of commission's test well 2 miles north of Lindenhurst.*

	Feet.
1–2. Surface loam	0– 2
3–5. Medium yellow sand	2–12
6. Very light-colored sand and gravel; small percentage of glacial material	14–30.5

641. *Record of commission's test well 2 miles south of Wyandanch.*

	Feet.
1–2. Surface gravelly loam	0– 1
3–8. Very light-colored sand and gravel with a very small percentage of glacial material.	5–31

642. *Record of commission's test well near Pinelawn.*

	Feet.
1. Dark-colored surface loam	0–0.5
2. White sand and gravel with some erratics	5–42

643. The following analysis was made February 5, 1894, by C. F. Chandler, Ph. D. and Charles E. Pellew, E. M.:

Analysis of water from Colonial spring near Wyandanch.

	Parts per million.
Potassic sulphate	3.30
Potassium chloride	7.42
Sodium chloride	13.72
Calcic carbonate	5.09
Magnesic carbonate	3.03
Oxide of iron and aluminum	.26
Silica	7.55
Organic and volatile matter	1.50
Total residues on evaporation at 230° F	41.87

"The 'Colonial' is a pure alkaline water, showing unusual freedom from organic matter."

The analysis of the Mo-Mo-Ne spring was made by the same chemists, who pronounced it the purest water they had ever examined.

Analysis of the Mo-Mo-Ne spring near Wyandanch.

	Parts per million.
Potassic sulphate	2.00
Potassium chloride	1.08
Sodium chloride	8.20
Sodic carbonate	1.12
Calcic carbonate	1.56
Magnesic carbonate	2.30
Oxide of iron and aluminum	.28
Silica	8.01
Organic and volatile matter	3.35
Total residues on evaporation at 230° F	27.90

644. Mr. George Carll reports regarding this region: "My well was first dug 130 feet and gave a fair supply of good water. When the well was finished the bottom was a kind of a quicksand and clay, that at times would make the water of a whitish color. I afterwards sunk two terra-cotta tubes, making it 136 feet deep, and the water was from 12 to 15 feet in depth. About 500 or 600 yards to the north are never-failing springs. The wells north and south range from 20 to 50 feet in depth. I struck the same bed of clay at 47 feet, but there was nearly 3 feet difference in striking it in just the width of the well, and consequently I could get but little water."

645. Mr. Elliott states that the thin clay layer which occurs very near the surface in this well extends for about 1 mile south of his house, and north as far as Huntington.

Record of J. Elliott's well near Melville.

Wisconsin and Tisbury:	Feet.
1. Loam, sand, and gravel	0– 4
2. Clay	4– 5
3. Sand and gravel	5–56

648. All deep wells in this neighborhood lost more or less water in 1900–1901.

Record of A. C. Soper & Company's well near Fairground.

	Feet.
Wisconsin and Tisbury:	
1. Dug well (sand)	0–120
Cretaceous:	
2. Sand	120–130
3. Clay	130–200
4. Very fine sand, mixed with a little clay; plenty of water but could not pump on account of stopping up	200–260
5. Coarse sand; very good water; pumps without trouble	260–267

649. *Record of F. Gallienne's well near Huntington.*

	Feet.
1. Glacial sand and gravel	0– 65
2. Dark-gray sand and clay	65– 70
3. Dark dirty-gray sand and gravel (probably glacial)	70– 90
Cretaceous:	
4. Very fine, dark-colored, silty, micaceous sand	95–120
5. Clay	120–200

650. Mr. Darling states that this is a gravity system depending on a ground reservoir situated 170 feet above mean high tide. The material penetrated in the group of driven wells is as follows:

Record of wells of Huntington waterworks, Huntington.

	Feet.
Wisconsin:	
1. Silt, mixed with clay	0– 5
2. Loam, passing into hardpan	5–25
Tisbury:	
3. Water-bearing gravel	25–60

Each well will yield 150 gallons per minute without lowering the water below the suction limit.

652. *Record of well of Huntington Light and Power Company near Halesite.*

	Feet.
Recent:	
1. Filled ground	0– 6
2. Swamp deposit	6–10
Tisbury:	
3. Dark sand and gravel	10–70
Sankaty? :	
4. Blue clay	70–71
Jameco? :	
5. Light yellowish gravel	71–75

653. *Record of R. F. Carmen's well near Centerport.*

	Feet.
Tisbury:	
1. Sand and gravel	0–154
Cretaceous:	
2. Blue clay	154–229
3. White gravel	229–258

654. *Record of R. S. McCrary's well near Centerport.*

	Feet.
Wisconsin and Tisbury:	
1. Coarse sand and some water	0–161
2. Sand	161–175
Jameco? :	
3. Multicolored stones as large as a man's fist	175–185

655. *Record of C. A. Hallock's well near Centerport.*

	Feet.
Wisconsin:	
1. Surface gravel	0– 4
Cretaceous:	
2. Pink clay: solid, sticky	4–38
3. Dark-colored gravel: water bearing	38–42

657. *Record of J. J. Robinson's well near Centerport.*

	Feet.
1. Dug well	0– 26
2. Bluish sandy clay	26–110
3. Yellow gravel	110–117

658. This plant was originally supplied from springs which yielded about 200 gallons per minute. The water from these was collected in a basin at the pumping station and then lifted to a ground reservoir having a capacity of about 250,000 gallons. Early in 1903 two very successful artesian wells were completed, and the spring supply has now been abandoned. The wells, which are 8 inches in diameter and 47 feet deep, are situated about 32 feet above mean high tide, and it has been found that 250 gallons per minute must be pumped from them to cause them to cease flowing. The ground reservoir is still used to supply the lower parts of the town, and an Acme system, having storage capacity of 25,000 gallons, has been installed for high-level service.

The following samples from one of the wells have been furnished by Mr. Henry Cabre, driller:

Record of well of Northport waterworks, Northport.

	Feet.
Wisconsin:	
1. Clayey gravel	0– 1
2. Silty sand, fine, dark reddish brown	1– 3
3. Very fine, reddish brown, clayey sand	3– 5
4. Reddish brown silt to small gravel; contains a considerable percentage of erratics	5–10
Tisbury:	
5–6. Medium, dirty, yellow sand	10–20
7. Fine white sand to coarse gravel (doubtfully glacial)	20–25
8. Fine, dirty, yellow sand	25–30
9. Medium sand	30–35
10–13. Medium sand to small gravel	35–48
14. Medium, dirty, yellow sand	48–51

This whole section, while not pronouncedly glacial, is probably to be regarded as composed of reworked material of Glacial age.

659. *Record of A. O. Gildersleeve's well near Larkfield.*

	Feet.
Wisconsin and Tisbury:	
1. Coarse sand, mixed with gravel and small stones	0– 50
2. Coarser sand	50–186

660. *Record of Fred Nevins's well near Northport.*

	Feet.
Wisconsin:	
1. Loamy clay.	
Tisbury:	
2. Sand, becoming coarser with increasing depth.	
3. Water-bearing sand at	165
4. Sharp white sand, water bearing, at	196

662. The following analysis was made by George A. Ferguson and Raymond J. Nestell, November 30, 1901:

Analysis of water from F. J. Smith's well near Northport.

	Parts per million.
Chlorine in chlorides	19.252
Equivalent in sodium chloride	31.774
Phosphates	None.
Nitrogen in nitrates	4.490
Nitrites	None.
Free ammonia	.040
Albuminoid ammonia	.040
Hardness equivalent in calcium carbonate:	
Temporary	56.000
Permanent	18.000
Organic and volatile matter	35.000
Mineral matter after ignition	125.000
Total solids at 230° F	160.000

663. This flowing well consists of a short pipe driven into an old spring site. The water rises 5 feet in the pipe. It is a good example of a type of well common on the north shore which is on the border line between a spring and an artesian well. (See fig. 33.)

664. *Record of D. B. Moss's well near Little Neck.*

	Feet.
1. Fine sand to water level	0–48
2. Gray clay	48–
3. Very fine brown sand, some water	–67
4. Coarse white gravel	67–75

666. *Record of well of P. Van Iderstine's Sons, Little Neck.*

Tisbury:	Feet.
1. Light-colored coarse sand and gravel	0–130
2. Water-bearing gravel	130–143

669. This is the Port Eaton well reported by Darton,[a] who gives the following record, furnished to him by Mr. Nimmo:

Record of Dr. O. L. Jones's well on Eaton Neck.

	Feet.
1. Quartz gravel and sand	10
2. Quartz gravel and sand	20
3. Fine sand mixed with clay	30
4. Gravel	40
5. Sand and fine gravel	50
6. Sand and fine gravel	60
7. Coarse gravel	70
8. Coarse gravel	80
9. Fine gravel	90
10. Fine gravel	100
11. Gravel and sand	110
12. Fine gravel	120
13. Coarse gravel	130
14. Fine yellow sand	140
15. Fine yellow sand mixed with mica	150
16. Lighter-colored sand with mica	160
17. Coarser sand; no mica	170
18. Coarser sand; no mica	180
19. Fine red sand	190
20. Coarse straw-colored sand	200
21. Very coarse sand	205
22. Fine light-colored sand	210
23. Clear gravel	215
24. Light coarse sand	220
25. Light coarse sand	225
26. Coarse gravel	230
27. Coarse gravel	240
28. Yellow sandy clay	250
29. Sharp coarse sand	255
30. Sand and gravel	260
31. Clear, fine, light-yellow sand	265

While salt water was reported in this well to a depth of 205 feet, at 263 feet an excellent supply of fresh water is said to have been obtained which flowed slightly above the surface. Attempts to develop this brought in salt water, and Mr. C. H. Danis, who afterwards worked on the well, reported that he could get no fresh water. The well was deepened to 340 feet through sand and gravel containing salt water.

670. Mr. Bevin has kindly furnished the Survey with the following samples from this well:

Record of L. A. Bevin's well on Eaton Neck.

	Feet.
Pleistocene:	
1–2. White sand and gravel, with a percentage of erratics	15– 30
Cretaceous:	
3. Medium-coarse white sand	40
4–6. Sand and small pebbles with a rather pinkish cast	50– 75

[a] Darton, N. H., Artesian-well prospects in the Atlantic Coastal Plain region: Bull. U. S. Geol. Survey No. 138, 1896, p. 35.

Cretaceous—Continued.	Feet.
7. Coarse pinkish white sand	80
8–9. Medium, white, micaceous sand	90–100
10. Very fine, gray, micaceous sand	110
11. Medium to coarse white sand	120
12. Small angular quartz pebbles, evidently broken from larger ones	130
13. Medium to coarse white sand	130
14. Medium white sand	150
15. White clay ("kaolin")	159–160
16. Small white quartz pebbles	165
17–20. Fine, gray, micaceous sand	250–300
21–25. Medium-coarse white sand	215–240
26–31. Fine, white, micaceous sand	250–300
32–34. Medium yellowish white sand	310–330
35–39. Fine sand and small quartz pebbles	335–350

Nearly all the samples contain fragments of milk-white chert, generally quite soft; when first seen they may be mistaken for white, calcareous concretions.

Mr. Danis reports that fresh water was encountered at a depth of 12 feet, and that below that nothing but salty water was found. The well is about 5 feet above high tide, and flows a little salty water at high tide.

671. The following record has been furnished by Mr. E. K. Hutchinson to the New Jersey Geological Survey: [a]

Record of Dr. E. H. Muncie's well on Muncie Island, New York.

	Feet.
Recent:	
1. Muck and sand with shells	0– 10
Wisconsin? and Tisbury:	
2. Heavy, yellow, micaceous sand and gravel, with water salt as the ocean, standing nearly at the surface of the meadow; this stratum is very similar to that obtained from most of the shallow wells on Long Island	10– 45
Sankaty? and Jameco?	
3. Clay; fine sand like beach sand; sand and clay mixed; color, blue and gray	45–150
Jameco? and Cretaceous:	
4. Clay, sand, etc., much like the last, only darker, with water which flowed 14 gallons a minute over the top of the casing, which was 2 feet above the ground. This water was fresh, but was colored black; about three wheelbarrow loads of wood (lignite) was pumped out; the pipe seemed to be in wood	150–200
Cretaceous:	
5. Lighter colored sand and clay mixed; amount of lignite gradually decreased. Sand a little heavier at the base where good water was obtained. Water flowed 8 gallons a minute from 2-inch pipe 2 feet above the surface	200–270

Doctor Muncie reports: "The present well flows 15 gallons per minute; the first water obtained flowed for about 6 months and then stopped. At first the flow was about 30 gallons per minute, but the water ontinued dirty."

673. The Long Island Railroad Company have furnished the following partial analysis made January, 1901:

Analysis of water from railroad well near Babylon.

	Parts per million.
Total solids	81.39

674. Mr. E. Camerdon, chief engineer, reports that two of the wells at this place were put down in 1893, and two in 1898; each well will yield 300 gallons per minute. The section is as follows:

[a] Ann. Rept. Geol. Survey New Jersey for 1899, 1900, p. 79.

Record of Sumpwams Water Company's well near Babylon.

	Feet.
Wisconsin and Tisbury:	
1. Surface loam	0– 3
2. Fine white sand	3–54
3. Coarse sharp sand	54–60
4. Very clean white gravel	60–70

The water contains no iron, but shows slight traces of alum and salt. A detailed description of this plant will be found in the Engineering Record, volume 43, 1901, pages 28–30.

675. When the original site of the Great South Bay Water Company plant, No. 691, was abandoned, the station was moved to this place. The present plant consists of twenty 5-inch wells, 40 to 45 feet deep, with a capacity of 2,250,000 gallons per day.

680. *Record of C. S. Burr's well near Kings Park.*

	Feet.
1. Dug well	0–118
Cretaceous:	
2. Pink sand	118–138
3. White sand	138–142

681. *Record of Captain Clarke's well near Elwood.*

	Feet.
1. Dug well	0– 90
Cretaceous:	
2. Dark, quite fine sand, sticky, no water	90–170

683. *Record of Wm. Herod's well near Kings Park.*

	Feet.
1. Sandy loam	0– 4
Tisbury and Cretaceous?	
2. Medium white sand with occasional thin streaks of clay	4–152

685. Mr. Thompson reports: "I have put down five 6-inch flowing wells, the water from which is used for trout hatching and growing. The first well was sunk about ten years ago. I sunk a 1¼-inch pipe, and got a good flow at 33 feet. A 6-inch pipe gave 50 gallons per minute at 33 feet. I then drove a 1¼-inch pipe inside of the 6-inch pipe, and at a depth of 45 feet got a nice flow."

Mr. H. J. Dubois, the driller, reports the following section for two wells on the south side of the ravine:

Record of Edw. Thompson's wells near Middleville.

	Feet.
Wisconsin and Tisbury:	
1. Red loamy sand at the surface, becoming coarser and passing into gravel below	0–32

A deeper well, put down on the northern side of the ravine, showed the following section:

Record of Edw. Thompson's well near Middleville.

	Feet.
Wisconsin and Tisbury:	
1. Gravel with only a small amount of water	0– 30
Cretaceous?	
2. Dark-brown clayey sand, becoming coarser below and yielding artesian water	30–160

686. *Record of J. F. McGiff's well near Fort Salonga.*

	Feet.
Wisconsin:	
1. Soil	0– 5
Tisbury:	
2. Ferruginous sand	5– 6
3. Clean, light-colored, pebbly sand	6–113
Cretaceous:	
4. Tenacious sandy clay	113–118
5. Water-bearing gravel	118–

688. Mr. Velsor has furnished the following samples from this well:

Record of Doctor Gillette's well near Fort Salonga.

	Feet.
Wisconsin:	
1. Very fine light grayish loam	0– 8
Tisbury:	
2. Glacial sand and gravel, for the most part quite clean, but containing a little silt between 35 and 38	8–73

Below 45 feet the samples show quite a little ferruginous concretionary material.

691. This was the site of the original pumping station of the Great South Bay Water Company. The supply was from a gang of 5-inch wells, 60 feet deep, of which Mr. C. A. Lockwood gives the following data:

Record of old wells of Great South Bay Water Company at Bayshore.

	Feet.
1. White beach sand becoming finer near the bottom of the well	0–60

For the first two years these wells, of which there were 12 or 15 in all, yielded a sufficient supply, but at the expiration of that time the demand increased, and a 350-foot well was sunk to obtain a greater supply. The material encountered in putting down this well was all white beach sand with some lignite at 300 feet. The water from the gang of 60-foot wells became more and more charged with iron, and had a smell similar to that of decayed vegetation; its taste was also bad. It was for this reason, together with the fact that a greater supply was desired, that the deep tests were sunk and, when these failed, the station was moved to No. 675.

Mr. Sands, the superintendent, has furnished the following notes regarding these deep test wells made by Mr. John C. Lockwood, the former president of the Great South Bay Water Company, who had charge of the drilling:

Record of deep test wells of Great South Bay Water Company at Bayshore.

	Feet.
Wisconsin and Tisbury:	
1. Yellow sand and gravel	0– 59
Sankaty ?:	
2. Clay (15 or 20 feet thick)	59–
Cretaceous:	
3. No record.	
4. Clay	144–146
5. No record.	
6. Clay (15 or 20 feet thick)	242–

"At 262 feet got strong flow, water rising 9 feet 6 inches above surface when casing was run upward."

The following analysis was published in the first rules and regulations of the company:

Analysis of water from old wells of Great South Bay Water Company at Bayshore.

[Analysis by C. F. Chandler, Ph. D., New York, December 5, 1889.]

	Parts per million.
Appearance in 2-foot tube	Clear, colorless.
Odor	None.
Taste	None.
Chlorine in chlorides	8.10
Sodium chloride	16.78
Phosphates	None.
Nitrogen in nitrites	None.
Nitrogen in nitrates	.02
Free ammonia	.17
Albuminoid ammonia	.07
Total hardness	19.03
Permanent hardness	19.03

	Parts per million.
Organic and volatile matter	3.99
Mineral matter	44.87
Total solids at 240° F	48.86

"The total amount of solid matter contained in the water is extremely small. There are no phosphates and no nitrites, both of which are regarded as evidences of contamination when present. The nitrogen in the form of nitrates is very small, and the free and albuminoid ammonia is moderate."

692. *Record of Strong well near Bayshore.*

	Feet.
1. Sand; no change in texture or color	0–67

694. *Record of commission's test well near Bayshore.*

	Feet.
Pleistocene:	
1–2. Yellow surface loam	0 – 1.5
3. Medium yellow sand	5 – 5.5
4–5. White sand and gravel	10 – 16
6–21. Grayish white sand and gravel	20 –100.5
Cretaceous?:	
22. Very dark brownish gray, micaceous, clayey sand	101.5–102.5

Samples 1 to 21 apparently represent glacial outwash. See Table XII.

695. *Record of commission's test well near Bayshore.*

	Feet.
1–2. Surface sandy loam	0– 2
3. Medium yellow sand	5– 5.5
4. Coarse sand and small gravel with glacial material	10–10.5
5–6. Light yellowish white fine sand and small gravel	15–20.5
7. Small gravel with a little fine sand, containing some glacial material	25–26
8–9. Fine sand to small gravel	30–36

The whole section of this well is composed of glacial outwash. See Table XII.

696. *Record of commission's test well near East Islip.*

	Feet.
Wisconsin and Tisbury:	
1–2. Sandy loam	0– 3
3. Light-yellow fine sand to small gravel	3– 5
4. Grayish white sand and gravel, with considerable glacial material	5–10
5–6. Light reddish brown sand and gravel, with a small percentage of glacial material	10–20
7–8. Light yellowish white fine to medium sand, not clearly glacial	20–30

697. *Record of commission's test well near Brentwood.*

	Feet.
1–2. Sandy loam	0– 1.5
3–8. Grayish white sand and gravel: probably glacial outwash	5–30

See Table XIII.

698. *Record of commission's test well near Brentwood.*

	Feet.
1–3. Surface loam; some gravel	0– 5.5
3–8. Outwash sand and gravel	10–30.5

See Table XIII.

699. *Record of commission's test well near Islip.*

	Feet.
1–2. Yellow surface loam	0– 2
3. Dark, humus-stained, medium sand	5– 5.5
4–5. Medium light-yellow sand	10–16
6. Small gravel, with a noticeable percentage of glacial material	20–21
7–9. Dirty, yellow, fine sand to small gravel	25–40.5

This whole section appears to be of glacial origin.

700. *Record of commission's test well near Islip.*

	Feet.
1–2. Yellow loamy sand	0– 1.5
3–8. Light grayish sand and gravel, with a small percentage of glacial material	5–31
9–10. Medium light-yellow sand: age very doubtful	35–41

701. *Record of commission's test well near Islip.*

	Feet.
1–2. Yellow gravelly loam	0– 2
3. Dark reddish brown sand and gravel with considerable glacial material	2– 5
4. Light-yellow medium sand to coarse gravel, with only a small percentage of glacial material	5– 9.6
5. Very dark reddish-brown sand and gravel; very doubtfully glacial	15–35

702. *Record of commission's test well near Central Islip.*

	Feet.
1. Black loamy sand	0 – 0.5
2–4. Fine to medium light yellow sand	0.5–10
5–7. Light yellow sand and gravel with glacial material	12 –25

703. *Record of commission's test well near Central Islip.*

	Feet.
1–2. Yellowish-brown sandy loam	0– 2
3. Medium light yellow sand	2– 5
4–9. Light yellow sand and gravel with a little glacial material	5–35

705. Mr. Darling states that the two wells at this point furnish 150 gallons of water per minute with deep-well pumps; with direct suction he believes they would yield 250 gallons each. He has installed an Acme system with a storage capacity of 10,000 gallons.

Record of wells at St. Joseph's in the Pines, near Brentwood.

	Feet.
1. Sand	0–27
2. Water-bearing sand	27–32
3. Clay	32–35
4. Water-bearing sand	35–52

706. Mr. Codman writes regarding this locality: "In excavating for cellars or wells there is often found at a depth of 2 to 5 feet a layer of grayish-blue deposit, locally called 'blue clay.' This layer, which is 2 or 3 feet thick, on drying shows a clayey fracture, though it is wholly devoid of plastic qualities. I have washed it and find it a very fine sand. I consider it rock flour."

One mile south of the main line of the railroad the water stratum is found at a depth of 28 feet; 1 mile north of the track the depth gradually increases to 52 feet.

707. *Record of commission's test well near Brentwood.*

	Feet.
Wisconsin and Tisbury:	
1–2. Reddish yellow surface loam	0– 3
3. Medium yellow sand with a little gravel	3– 5
4. Dark-drab silty sand, with a few pebbles	5– 21

Wisconsin and Tisbury—Continued.	Feet.
5–8. Yellowish white sand and gravel	21– 40
9–10. Coarse sand and gravel, with a very noticeable percentage of erratics for this region	45– 50
11–12. Fine to coarse light yellow sand and gravel	50– 60
13. Fine to coarse gravel with some sand and a small percentage of glacial material	60– 65
14–18. Light yellowish sand and gravel, glacial	65– 88
19. Fine to medium yellow sand	88– 92
20. Light reddish-brown sand and gravel, with erratics	92– 97
Cretaceous?:	
21. Fine, yellowish brown sand and gravel	97–100
22. Fine to medium, grayish-yellow sand	100–103

See Table XIII.

708. *Record of commission's test well near Brentwood.*

Wisconsin and Tisbury?:	Feet.
1. Black sandy loam	0 – 0.4
2. Light-yellow silt	0.4– 2.5
3–11. Light-yellow or grayish yellow sand, with considerable erratic material (glacial outwash)	2.5–44

See Table XIII.

710. *Record of Charles Blyndenburgh's well near Hauppauge.*

Wisconsin:	Feet.
1. Coarse gravel	0–20
Wisconsin and Tisbury:	
2. Fine sand, with thin layer of clay at 25 feet	20–45
Tisbury:	
3. Coarse gravel	45–49.5

711. Mr. Price has kindly furnished the following samples from this well:

Record of C. B. Pedrick's well near Smithtown.

Pleistocene:	Feet.
1. Very fine, brown, micaceous sand	90
2. Grayish yellow silty sand and small, rather angular, quartz gravel; contains a few pebbles of glacial origin	163
3. Very fine, bright-yellow, micaceous silt, with quartz pebbles	165
4. Medium yellow sand	168

The section reported by Mr. Price is as follows:

Record of C. B. Pedrick's well near Smithtown.

Pleistocene:	Feet.
1. Coarse gravel	0– 20
2. Very micaceous quicksand	20– 95
Pleistocene?:	
3. Stiff clay with quartz pebbles	95–165
4. Yellow sand with small supply of water	165–168

712. *Record of J. B. Payne's well near Smithtown.*

	Feet.
1. Gravel and sand, with surface water	0– 20
2. Clay	20– 60
3. Quicksand and water	60–100
4. Clay	100–118
5. Gravel and sand	118–127

This well was never completed.

713. *Record of Frederick Noback's well near Smithtown Branch.*

	Feet.
1. Sand, with surface water	0– 30
2. Clay with stone (stones were black and did not wash white)	30–105
3. Black material	105–110
4. Sand and gravel	110–125

The sand from stratum 4 of this well rose in the pipe and was cleaned out and the water at once rose to within 50 feet of the surface.

714. Mr. Redwood has kindly furnished a sample from a depth of 95 feet; it is a glacial gravel, similar to that found in upper part of wells in this section.

715. *Record of E. M. Smith's well near Smithtown Branch.*

	Feet.
Wisconsin:	
1. Surface loam	0– 5
2. Clay containing a few pebbles	5– 40
Tisbury:	
3. Fine white sand	40– 83
4. Good gravel	83–100

716. *Record of C. F. Leeman's well near Smithtown Branch.*

	Feet.
1. Surface loam	0– 5
2. Good gravel	150–160

Mr. Rogers was unable to finish a complete log of this well. He thinks no clay was encountered.

717. *Record of Rassapeague Club's well near Smithtown Branch.*

	Feet.
Wisconsin or Tisbury:	
1. From medium white sand at the top gradually becoming coarser until coarse gravel is encountered	0–18

The coarse gravel in this well at 18 feet furnishes artesian water.

718. Mr. George Schmidt reports that one bed of clay was encountered in this well. He could give no further information regarding it.

719. These wells were completed in 1899 and are pumped with an air lift. The supply is stated to have decreased and the water to be hard and salty.

Record of well of Society of St. Johnsland at Kings Park.

	Feet.
Pleistocene(?):	
1. Sand and gravel, with surface water below 10 feet	0–15
2. Clay	15–20
3. Sand, with main water-bearing horizon at about 40 feet	20–90

720. *Record of W. W. Kenyon's well on Nissequogue River.*

	Feet.
Tisbury:	
1. Gravel	0–130
Cretaceous:	
2. Dark-blue clay	130–170
3. Grayish brown sticky sand	170–206
4. Coarse white gravel	206–212

721. It is stated that the water in this well at first stood 12 feet below the surface, but that after pumping it rose to 8 feet.

Record of W. J. Matherson's well on Nissequogue River.

	Feet
1. Dug well	0– 20
2. Sand and gravel	20– 35
3. Black clay	35– 45
4. Marsh mud and sand	45–100
5. Very fine white sand	100–130
6. Coarse sand with water	130–146

722. Mr. Rogers has kindly furnished a sample from this well from a depth of 80 feet; it consists of brown glacial sand and gravel.

723. *Record of R. H. Smith's well near Stony Brook Harbor.*

Wisconsin and Tisbury:	Feet.
1. Sand	0– 60
2. Mixture of clay and sand	60– 90
3. Fine sand and gravel, growing coarser	90–117

724. No clay or quicksand was encountered in this well, the material being entirely sand and gravel.

727. *Record of C. R. Roberts's well near Oakdale.*

	Feet.
1. Bog, bearing foul-smelling water	0 – 15
2. Fine black gravel	15 – 17.5
3. Muck, bearing foul-smelling water	17.5–170

At the depth of 170 feet, no better water having been encountered than that found at the top, the well was abandoned. Mr. Kirk reports that in the vicinity of Swan Creek the same conditions are often encountered.

729. *Record of commission's test well near Sayville.*

	Feet.
1. Black loamy sand	0 – 0.4
2. Yellow loamy sand	0.4– 2
3–11. Light-yellow or grayish yellow fine sand to small gravel, with a few glacial pebbles	2 –45

See Table XIII.

730. *Record of commission's test well near Ronkonkoma.*

	Feet.
1. Black loamy sand	Surface.
2. Yellow loamy sand	Subsoil.
3–6. Light grayish white sand and gravel (glacial)	2–20
7. Fine to medium white sand, with traces of lignite	24–25
8–14. Light-yellow fine sand to small gravel, with a few erratic fragments in the lower samples	29–62

731. *Record of commission's test well near Ronkonkoma.*

	Feet.
1. Black loamy sand	0 – 0.6
2. Yellow loamy sand	.6– 2
3–5. Grayish yellow sand and gravel with a few erratics	4 – 5
6. Very bright, vermilion, clayey sand	18
7–13. Very light grayish yellow sands and gravel, with a small percentage of glacial material	24–56

See Table XIII.

732. *Record of commission's test well near Ronkonkoma.*

	Feet.
1. Black loamy sand	0 – 0.5
2. Yellowish loamy sand	.5– 3
3–4. Light-yellow sand with a few gravels	4 –10
5. Very fine to medium grayish brown sand	14 –15
6–9. Reddish yellow sand and gravel, with pronounced glacial pebbles	19 –35

See Table XIII.

734. *Record of John Klaiber's well near Ronkonkoma.*

Wisconsin and Tisbury:	Feet.
1. Sandy loam	0– 8
2. Coarse sharp sand; no stones nor clay	8–81

736. The location of this well as given on the map is probably slightly in error.

Record of William Ralston's well near Lake Ronkonkoma.

Wisconsin and Tisbury:	Feet.
1. Surface loam	0– 5
2. Coarse gravel	5–12
3. Medium white sand	12–22
4. Black hardpan, with stones about the size of walnuts	22–25
5. Medium white sand	25–54

737. *Record of J. Weber's well near Lake Ronkonkoma.*

Pleistocene:	Feet.
1. Sand	0– 13
2. Sand, with a little gravel and occasional streaks of clay	13– 25
3. Coarse sand	25– 38
4. Clay; no bowlders	38–103
5. Water-bearing sand	103–117

Mr. W. T. Arthur has kindly furnished the following samples from this well:

Record of J. Weber's well near Lake Ronkonkoma.

	Feet.
1. Medium to very coarse, dirty, quartz sand, with some small gravel; has the general aspect of glacial material, and contains a few rounded fragments of soft, fine-grained, mica schist, with biotite	103–117
2. Very fine, light-gray, silty sand, with much muscovite	117–

The water from the sand and gravel between 112 and 117 rises just to lake level.

738. There was 8 feet of water in pipe when the well was completed; the lake level was then said to below. Later the lake level rose and a corresponding rise of the water in the well occurred.

Record of G. E. Plunkett's well near Lake Ronkonkoma.

	Feet.
1. Dug well	0–60
2. Coarse sand	60–70

739. *Record of R. W. Newton's well near Lake Ronkonkoma.*

	Feet.
1. Surface loam	0– 5
2. Fine white sand	5–55
3. Clean white gravel	55–60

Mr. Rogers reports that where waterworn gravel is encountered at any depth exceeding about 50 feet the supply of water is always abundant and good. This statement of Mr. Rogers is equivalent to saying that wherever a coarse gravel is found below the main water table an abundant supply is obtained (p. 67).

A sample furnished by Mr. Rogers, marked "Newton well, 60 feet, 1896," is fine light-yellow glacial sand with some gravel.

740. Water stands 8 feet below surface; this is said to be at the same level as Lake Ronkonkoma.

Record of well of W. Imhauser estate near Lake Ronkonkoma.

Pleistocene:	Feet.
1. Clay; no bowlders	0–62
2. Medium sand	65–75

741. Mr. Ralston, who has lived near Lake Ronkonkoma all his life, reports that in digging or driving wells on the west side of the lake a considerable thickness of clay is encountered in nearly every instance, while on the east side the material is for the most part sandy, the sand being of the kind known as "beach sand."

Record of Nelson Newton's well near Lake Ronkonkoma.

	Feet.
1. Surface loam	0– 5
2. Yellow sand	5–10
3. White beach sand	10–33

743. *Record of W. H. Warner's well near Lake Ronkonkoma.*

Wisconsin and Tisbury:	Feet.
1. Fine sand	0 –35
2. Clay	35 –36. 5
3. Sand and gravel	36. 5–47

744. In wet weather the water is milky, indicating, Mr. Terry thinks, that clay lies a short distance below 86 feet.

Record of John Morrissey's well near Lake Grove.

Wisconsin and Tisbury:	Feet.
1. Stony sand	0– 8
2. Coarse sand; no stones	8–15
3. Yellow sand, described as being like the subsoil in sandy places	15–17
4. Coarse sand, with stones varying in diameter from 4 to 6 inches	17–45
5. Stones and gravel	45–58
6. Ordinary sand	58–86

745. *Record of Irving Overton's well near Lake Grove.*

Wisconsin and Tisbury:	Feet.
1. Stony top soil	0– 6
2. Finer material to fine sand	6–14
3. Clean white sand	14–35
4. Gravel and clay	35–45
5. More or less stony gravel	45–52
6. Ordinary sand	52–

746. *Record of Doctor Monecke's well near Lake Grove.*

	Feet.
1. Light sandy top soil	0– 4
2. Yellow sand subsoil, no stones	4– 8
3. Hard blue clay, no stones or pebbles	8–21
4. "Mica mud"	21–24

Water rose in the pipe, stopping further work. The water was muddy, but had no bad odor or bad taste.

In putting down another well on this same property for Doctor Monecke, leaves and muck were encountered at 23 feet. There was a 14-inch stratum of this material, and the water coming from it had a very bad odor.

749. *Record of commission's test well near St. James.*

	Feet.
1. Dark humus-stained loam	0 – 0. 3
2. Reddish brown sandy loam	3 – 3
3. Brownish yellow sand and gravel	3 – .6
4–11. Dirty, gray, fine sand to coarse gravel; a small quantity of glacial material	6 –45
12–14. Dark, yellowish gray, very fine to coarse sand, glacial	45 –59

750. *Record of Father Ducey's well near St. James.*

Wisconsin:	Feet.
1. Hardpan, a compact mixture of sand and gravel, containing bowlders	0– 60
Tisbury:	
2. Gravel and sand	60–150

Mr. Rogers has sent the following sample from this well:

	Feet.
1–2 Clean, light-colored sand and gravel, clearly glacial, perhaps Tisbury	140–150

751. *Record of Jerome Saxe's well near St. James.*

Pleistocene:	Feet.
1. Very coarse stony gravel	0– 30
2. Hardpan	30–150
3. Clay containing a few stones	150–160
4. Gravel, etc	160–208
5. Quicksand	208–245
6. Clean white gravel	245–250

Mr. Rogers has furnished the following sample from this well:

	Feet.
1. Clean, light-colored glacial sand and gravel at	250

752. *Record of D. Emmett's well near St. James.*

	Feet.
1. Sand and gravel stones from the size of a fist to a robin's egg	0– 30
2. Loam (?)	30– 90
3. Quicksand (?)	90–140
4. Clay, with thin layers of gravel	140–190
5. Quicksand	190–290
6. Gravel	290–300

753. Mr. Rogers reports this well to be 82 or 83 feet above the level of the Sound, and that the water in the well rose to the level of the water in the Sound. He has furnished a sample of clean, light-colored glacial sand and gravel taken at a depth of 97 feet:

Record of D. Emmett's well near St. James.

Wisconsin and Tisbury:	Feet.
1. Sand and gravel	0–30
2. Light-yellow fine sand	30–40
3. Water-bearing gravel	40–97

754. According to the location indicated on the map, the depth to water in this well is abnormally great, and it is quite possible that the location is an error.

Record of D. Emmett's well near St. James.

Wisconsin and Tisbury:	Feet.
1. "Till" (probably also including outwash gravel)	0–140
Cretaceous:	
2. Fine pink sand	140–160

755. *Record of commission's well near St. James.*

Wisconsin:	Feet.
1–2. Brown surface loam	0– 4
3. Very fine yellow loam and sand	4– 5
Wisconsin and Tisbury:	
4–16. Fine sand and small gravel, yellowish gray above and darker below (glacial)	5–69
Tisbury:	
17–20. Dark, yellowish gray, fine to medium sand, probably glacial	69–90

The material shown in samples 17–20 is the same as that shown in samples 12–14 in well No. 749. See Table XIII.

756. *Record of commission's test well near St. James.*

Wisconsin and Tisbury:	Feet.
1. Humus-stained surface loam	0 – 0.4
2. Yellow sandy loam	.4– 3
3. Yellow sand	3 – 5
4–16. Gray sand and gravel (considerable glacial material)	5 –70

757. This well was first dug to 94 feet and then the 6-inch pipe sunk 40 feet. The sinking of the pipe did not in any way affect the water level in the well.

759. *Record of George Erland's well near Stony Brook.*

	Feet.
1. Surface loam	0– 10
2. Dark almost red sand	10– 60
3. Quicksand	60–160
4. Coarse, dark, almost red sand	106–107

760. *Record of W. Rowland's well near Setauket.*

	Feet.
Wisconsin:	
1. Hardpan	0– 25
Tisbury:	
2. Sand and gravel with one or two strata of hardpan	25– 60
3. Water-bearing gravel	60– 62
Cretaceous?:	
4. Quicksand mixed with some clay	62–251
5. Gravel	251–252

761. *Record of William Clarke's well near Setauket.*

	Feet.
1. Surface loam	0–10
2. Various strata of sand and gravel	10–
3. Yellow clay, containing no stones (2 feet thick).	
4. Quicksand.	
5. Coarse sharp sand	–90

762. *Record of Howard Wallace's well near Setauket.*

	Feet.
Wisconsin and Tisbury:	
1. Surface loam	0–12
2. Coarse sand and gravel	12–50
3. Quicksand	50–52
4. Coarse reddish sand	52–70

Mr. Rogers has furnished a sample marked "70 feet, 1896," which is clearly glacial material.

763. The following samples have been received from this well:

Record of W. T. Cox's well near Setauket.

	Feet.
Tisbury:	
1. Light, brownish yellow glacial sand and gravel, possibly Tisbury	0– 85
Cretaceous:	
2–3. Very fine, dark-gray, micaceous, sandy clay	85–132
4. Medium to coarse, white, quartz sand, with some mica and white clay	132–145
5. Fine and coarse, gray, micaceous sand	145–155
6. Light-yellow medium sand	155–180
7. Light-yellow clayey sand	180–188

Water is reported to have stood only 4 feet below the surface when well was between 145 and 155 feet, but at 188 feet it stood 10 feet below the surface. Under date of October 5, 1903, Mr. W. T. Cox reports: "The water came from fine gravel mixed with sand, which looked like brown sugar. The water was obtained, Mr. Hutchinson told me, at 320 feet. He measured the flow carefully and stated that it was 18 gallons a minute at low water and considerably more at high water. Water was abundant from 188 feet to the bottom of the well, but the fineness of the material prevented a flow, which commenced when a slightly coarser layer was encountered at 320 feet."

764. *Record of Nort House well at Setauket.*

	Feet.
Wisconsin:	
1. Hardpan	0–20
Tisbury:	
2. Medium white sand	20–40

765. *Record of Charles Benner's well near Setauket.*

	Feet.
Wisconsin:	
1. Hardpan (compact mixture of sand and gravel; brown in color)	0–20
Tisbury:	
2. Medium white sand	20–50

766. The elevation of this well is said to be 6 feet above tide level. At a depth of 38 feet it was abandoned on account of the constantly increasing supply of salty water. Mr. Rogers reports that several other wells on the same property 20 to 30 feet deep gave fresh water. One of these wells is about 10 feet above high water and the other 5 feet.

768. *Record of John Thatcher's well, Crane Neck.*

	Feet.
1. Surface loam	0–10
2. Gravel, with occasional streaks of hardpan	10–50
3. Clay and quicksand	50–56
4. Yellow gravel	56–65

769. *Record of well near Old Field Point.*

	Feet.
1. Hardpan	0–40
2. Clean, fine gravel	40–50

At the depth of 50 feet salt water was encountered and the well was abandoned.

770. A good water-bearing strata was encountered at 36 feet. Mr. Rogers reports that a number of wells in this immediate vicinity give a good yield of fresh water at about the same depth. Well No. 769 is the only exception of which he knows.

771. *Record of well near Mount Misery Point.*

	Feet.
Wisconsin and Tisbury:	
1. Sand, with salt water	0–110
Cretaceous?:	
2. Blue gravelly clay	110–165

772. *General section of wells about Sayville.*

	Feet.
1. Fine sand of different colors, sometimes red and sometimes white, changing to good, clear, water-bearing gravel	0–45

773. *Record of Long Island Railroad well at Bayport station.*

	Feet.
Wisconsin and Tisbury:	
1. Surface loam	0– 1
2. Yellow sand	1– 4
3. Clay; no bowlders	4– 5
4. White sand	5–28

There was no change in the coarseness of the material in stratum 4. Mr. Arthur reports that in digging wells near Bayport occasional patches of clay may be found, but that such occurrences are rare.

774. *Record of Sea Cliff Hotel well at Patchogue.*

	Feet.
Wisconsin and Tisbury:	
1. Loam	0–4
2. Medium reddish gravel	4–6
3. Blue clay; no stones	6–8
4. Very fine sand	8–

775. *Record of Nassau Oyster Company's well at Patchogue.*

	Feet.
1. Limbs, stumps, and trunks of trees	0– 9
2. Fine yellow gravel	9–12
3. Blue clay; no stones	12–14
4. Muck and black loam	14–49
5. Fine white sand	49–52
6. Black mud	52–72

At this depth very black water was encountered and the well was abandoned. The pipe was then pulled and the location changed 90 or 100 feet north, where the pipe was driven 19 feet through the following material:

Record of Nassau Oyster Company's well at Patchogue.

	Feet.
1. Sandy loam	0– 6
2. Medium yellow gravel	6– 9
3. Clean medium sand	9–19

776. *Record of T. J. Kirk's well near Patchogue.*

	Feet.
1. Loam	0– 4
2. Yellow gravel	4– 6
3. Fine white sand	6–10
4. Fine to coarse gravel	10–15
5. Pure white fine sand	15–28

778. *Record of commission's test well near Patchogue.*

	Feet.
Wisconsin and Tisbury:	
1–2. Surface loam	0– 3
3–13. Light, yellowish gray, speckled sand (nothing clearly glacial)	4– 55
14–20. Reddish brown fine to coarse sand (glacial)	59– 90
Cretaceous:	
22–28. Very fine, micaceous, gray to olive-green sand	99–129. 50
29. Very fine, reddish brown silty sand	131–133
30. Dark brownish gray, very fine silty sand	134–135
31. Dark yellowish brown silt to coarse sand	139–140

See Table XIII.

779. *Record of commission's test well near Patchogue.*

	Feet.
Wisconsin and Tisbury:	
1–2. Medium silty sand	0– 1
3. Medium light-yellow sand with gravel (probably glacial)	3– 5
4–12. Fine to medium light-yellow sand (glacial)	10–50

780. *Record of commission's test well near Patchogue.*

	Feet.
Wisconsin and Tisbury?:	
1. Black loamy sand	0– 0. 4
2. Medium yellow sand	0. 4– 2
3–12. Yellowish white fine to medium sand, with a few pebbles (age very doubtful)	3–50

781. *Record of commission's test well near Patchogue.*

	Feet.
Wisconsin and Tisbury:	
1–2. Yellow silt	0– 3
3. Yellowish brown medium sand	3– 5
4–9. Light grayish white sand and gravel; the gravel is quite mottled and is probably to be regarded as glacial	9–35
Cretaceous:	
10. Grayish white medium sand, with much silvery white muscovite; suggests Cretaceous material	39–40
11–12. Yellowish white fine to coarse sand	44–51

See Table XIII.

782. *Record of Reynolds well near Holbrook.*

Pleistocene:	Feet.
1. White sand and gravel	0–90

Mr. Kirk reports that there was no change in the material at increasing depths. At 65 feet a bowlder the size of a man's head was encountered.

784. *Record of commission's well near Farmingville.*

Wisconsin:	Feet.
1. Dark humus-stained sand	0 – 0.2
2. Yellow loam	.2– 2
3. Bright-yellow medium sand	3 – 5
4. Dark-gray sand and gravel, with much glacial material	9 –10
Tisbury:	
5–6. Fine to coarse yellow sand	14 –20
7–12. Light-gray sand and gravel, with some glacial pebbles	24 –50

785. *Record of A. P. Terry's well near Farmingville.*

Wisconsin:	Feet.
1. Sand	0– 4
2. Gravel and stones 2 to 12 inches in diameter	4– 16
Tisbury:	
3. Coarse sharp sand	16– 23
4. Gravel	23– 37
5. Sand	37– 46
6. Gravel and stones	46– 63
7. Coarse sand	63– 71
8. Coarse gravel	71– 73
9. Finer sand	73– 78
10. Sharp, white, coarse sand, with black specks	78– 86
11. Coarse gravel	86– 90
12. Coarse sand	90– 94
13. Sandy gravel	94–104
14. Coarse gravel and small stones	104–110

At 54 feet a stone 10 by 14 inches was taken out of this well.

786. *Record of August Fuch's well near Farmingville.*

Wisconsin:	Feet.
1. Stony loam	0–12
2. Coarse white sand, with occasional stones 3 to 5 inches in diameter	12–40
Tisbury:	
3. Medium white, clean sand	40–58
4. Yellow hardpan (a very hard and stony layer)	58–62
5. Medium clear, bright sand	62–65
6. Gravel	65–70

Mr. Terry reports that at 70 feet he struck "real" hardpan, on top of which water was found.

787. *Record of D. Schwarting's well near Farmingville.*

Wisconsin:	Feet.
1. Sand and stones	0–13
2. Coarser material; mixture of loam, gravel, and stones	13–17
Tisbury:	
3. Coarse dull-white sand	17–22
4. Sandy material, with some mica and an occasional stone	22–27

788. *Record of William Clark's well near Farmingville.*

Wisconsin and Tisbury:	Feet.
1. Heavy gravelly loam	0– 6
2. Fine gravel, with an occasional stone the size of one's fist	6–45
3. Coarse gravel	45–59

Material became coarser at increasing depths, and water was found in very coarse stony gravel.

789. *Record of Mrs. Max Richter's well near Farmingville.*

Wisconsin and Tisbury:	Feet.
1. Gravelly loam	0– 4
2. Sand, with an occasional stone	4–30
3. White clean sand	30–60

790. This well is described as at "Waverly, 3 miles northwest of Holbrook," and its exact location not known.

Record of Frank Franz's well at Waverly.

	Feet.
1. Sand and gravel	0–45
2. Gravel and stone, 4 to 6 inches in diameter	45–49
3. Sand, slightly yellow in color	49–55
4. Ordinary sand	55–80

791. *Record of J. F. Byrne's well near Selden.*

	Feet.
1. Sand and gravel	0–14
2. Coarse sand and occasional stones	14–30
3. Coarse stony gravel	30–45
4. Coarse, sharp, white sand, containing black specks which were thought to be iron pyrites	45–64

792. *Record of Doctor Emerson's well near Selden.*

	Feet.
1. Sandy top soil	0– 3
2. Medium, white, fine sand; no mica	3–14
3. Very fine, hard, gray material, with a great deal of mica; soft and velvety to the touch	14–17
4. Medium white sand; no stones	17–40
5. Coarse sand	40–43
6. Dark-colored fine sand	43–53
7. Coarse sand	53–

793. *Record of Axel Hodges's well near Selden.*

	Feet.
1. Light sand	0– 4
2. Medium sand, containing a little mica; no stones	4–14
3. Yellow sand, almost like subsoil	14–16
4. Mica sand, said to glisten in the sun like silver, this being probably due to the presence of muscovite; there were no stones in this stratum	16–38

On account of the increasing stickiness of the sand Mr. Terry believes that clay underlies it.

794. *Record of Adolph Sembler's well at New Village.*

	Feet.
1. Medium dull sand; no top soil	0– 4
2. Coarser yellow sand	4– 8
3. Very fine mica sand; from 8 to 32 feet the sides of the well stood up like a wall; there was no caving whatever	8–32
4. Blue clay; no stones	32–34
5. "Mica mud"	34–38

795. *Record of commission's test well near Terryville.*

	Feet.
Wisconsin and Tisbury?:	
1. Fine yellowish gray sand, evidently filling	0 – 0.3
2–3. Yellow sandy loam	.3– 6
4–5. Yellowish gray sand with a few erratics	6 –15
6–10. Very fine gray sand with some biotite	15 –38
Cretaceous?:	
11–16. Fine to coarse reddish yellow sand	40 –70

796. *Record of commission's well near Terryville.*

	Feet.
Wisconsin and Tisbury:	
1. Humus-stained surface loam	0 – 0.3
2. Dark reddish sandy loam	.3– 3
3–4. Light-yellow medium sand, passing gradually into bed below	3 –10
5–11. Fine grayish white sand with muscovite and biotite	10 –45
12–14. Medium to coarse light-yellow sand	45 –57

See Table XIII.

797. *Record of commission's test well near Echo.*

	Feet.
1. Dark humus-stained loam	0 – 0.3
2. Dark-yellow loam	.3– 4
3. Medium yellow sand	4 – 5
4–19. Dirty gray sand to small gravel; small percentage of glacial material	5 –85

Samples 13 and 14, 50 to 60 feet below the surface, show a very considerable amount of glacial material.

798. *Record of commission's test well near Echo.*

	Feet.
1. Humus-stained surface loam	0 – 0.4
2. Dark-yellow sandy loam	.4– 3
3. Medium yellow sandy loam	3 – 5
4–21. Dirty gray fine sand to small gravel; very small percentage of glacial material	5 –95

See Table XIII.

800. This well is approximately 5 feet above mean high tide. Mr. Overton reports it to be 63 feet deep, which would more nearly agree with the depth of the Port Jefferson Water Company's wells, which obtain their water at about a depth of 50 feet. They are also flowing wells. As the well was attached to a ram, the depth could not be measured readily.

Record of J. J. Overton's well near Port Jefferson.

	Feet.
1. Loam	0– 4
Tisbury:	
2. Coarse white sand with occasional layers of white gravel	4–20

801. *Record of J. L. Darling's well near Port Jefferson.*

	Feet.
Tisbury:	
1. Sandy loam	0– 4
2. Medium yellow to white sand	4–20
Cretaceous?:	
3. Sticky brown to drab colored clay	20–40
4. Medium white sand	40–96

The elevation of the surface at this well is approximately 50 feet above mean high tide. The clay described in stratum 3 is similar to that found in the brickyard 150 yards south of Mr. Darling's house.

803. The supply of the Port Jefferson Water Company is from two 6-inch wells, 54 feet deep, which will normally flow about 4 feet above the surface. One well tests 7,000 to 8,000 gallons per hour, while the two together give only 8,000 to 9,000. Mr. T. B. Rogers gives the following section of these wells:

Record of Port Jefferson Water Company's wells, Port Jefferson.

	Feet.
Wisconsin and Tisbury?:	
1. Surface loam	0– 5
2. Sand and gravel	5–51
3. Hardpan	51–54

Mr. Rogers also furnishes a sample of the main water-bearing stratum, which is a clean, highly erratic, glacial sand.

The Long Island Railroad Company has furnished the following partial analysis of water from the mains of the Port Jefferson Water Company (March 30, 1903):

Analysis of water from Port Jefferson Water Company's wells, Port Jefferson.

	Parts per million.
Total solids	40.18
Chlorine	8.04

804. This well will flow about 5 feet above high tide. By means of a ram it supplies the bank and adjoining buildings.

Record of N. W. Davis's well, Port Jefferson.

	Feet.
Tisbury:	
1. Medium white sand	0–75.5

806. Mr. Davis reports that this is a closed-point well and that he can give no record of the material passed through, but that it appeared to be very fine sand with probably some clay. He bases this opinion on the amount of fine sand which was pumped out during the water tests at different depths. At 140 feet very coarse material, probably coarse gravel, was encountered.

807. *Record of J. W. Brown's well near Port Jefferson.*

	Feet.
1. Brown loam	0– 3
Tisbury:	
2. Medium white sand	3–90

808. *Record of J. Biddle's well near Port Jefferson.*

	Feet.
Wisconsin:	
1. Gravelly sand and some bowlders	0– 15
Tisbury and Cretaceous?:	
2. Medium white sand with a little brown, sticky clay at about 100 feet	15–120

Attempts were made to dig a well on ground 20 feet higher, but the effort was abandoned on account of bowlders.

811. The following samples have been received from Mr. Rogers:

Record of well of Port Jefferson Company, Port Jefferson.

	Feet.
Tisbury:	
1. Medium light-colored sand (glacial)	212
2. Light-colored sand and gravel; fragments of ferruginous concretions and considerable erratic material	240
3. Light-colored glacial sand and gravel	265
4. Same as 3	280
Cretaceous:	
5. Dark-drab clay, containing some coarse quartz sand; leaves the fingers white as does Cretaceous material	325
6. Light-drab clay, containing some coarse quartz sand, evidently from laminated layer	340
7. Fine to medium, white, highly micaceous, quartz sand ("not much water")	370

812. Mr. Davis reports that the surface in the vicinity of this well is rather thickly covered with bowlders and that he expected to encounter them in putting down this well, but that not a single bowlder was encountered, nor even coarse gravel.

Record of J. H. Hopkins's well near Mount Sinai.

	Feet.
1. Surface loam	0– 3
Tisbury:	
2. Medium white sand	3–95

813. *Record of J. M. Shaw's well near Bellport.*

	Feet.
1. Surface loam and yellow sand	0– 4
Tisbury:	
2. White sand with no change in coarseness	4–45

814. *Record of W. McGee's well, 2 miles west of Yaphank station.*

Wisconsin and Tisbury:	Feet.
1. Loamy top soil, no stones	0– 4
2. Coarse sand	4–68

Mr. Terry reports that the material of this well was the most even in character that he ever found.

818. *Record of Judge Bartlett's well near Middle Island, New York.*

Wisconsin:	Feet.
1. Hardpan	0–39

Mr. Terry reports that the stones were embedded in a very heavy loam. Water was encountered at 8 feet, in a 6-inch stratum of yellow mud. Another similar stratum was found at 32 feet. In the spring of the year the water stands 8 feet below the surface; in the dry season at 30 or 32 feet. The water at the 8-foot level is impure.

819. *Record of Hawman Brothers' well near Rocky Point.*

	Feet.
1. Surface loam	0– 3
Tisbury:	
2. Medium white sand with no gravel nor clay	3–128

822. *Record of Mrs. Groty's well near Manor.*

Wisconsin?:	Feet.
1. Surface loam	0– 3
2. Clay, no stones	3–29
3. Sand	29–

824. Mr. Davis says that none of the water-bearing material in this well can be called gravel. In most of the wells in the vicinity of Port Jefferson he calculates on getting water a little above sea level, the elevation of the water level being greater at greater distances from the sea.

Record of G. E. Hageman's well near Wardenclyffe.

	Feet.
1. Brown loam	0–3
Tisbury:	
2. Medium white sand	3–123

825. Mr. Nikola Tesla reports the following section:

Record of Nikola Tesla's well near Wardenclyffe.

Tisbury and Cretaceous?:	Feet.
1. Fine sand	0–122
2. Gravel	122–124
3. Alternating layers of sand and gravel	124–166

"At a greater depth than that shown in this well layers of fine sand and gravel, each about 2 feet thick, alternate seemingly to an infinite depth. This was observed in digging a large shaft near the well, and it is assumed that the soil in the well is of the same character."

A sample furnished by Mr. T. B. Rogers, the driller, from a depth of 167 feet, is a clean glacial sand and gravel. The shaft referred to in Mr. Tesla's letter was 135 feet deep. In the bottom of this two pipes were driven at angles of 45 degrees. According to Mr. W. H. Beers, the driller, the section is as follows, depths along the pipe having been reduced to vertical depths:

Record of shaft sunk near Nikola Tesla's well, Wardenclyffe.

	Feet.
Tisbury:	
1. Sand and gravel in dug well	0–135
Cretaceous?:	
2. Fine gray sand	135–205
3. Coarse white gravel	205–223
Cretaceous:	
4. Fine white sand	223–347

826. According to Mr. Saxe, this well shows medium-white fine sand all the way to its bottom at 90 feet. A sample from a depth of 80 feet shows light-yellow sand not clearly glacial.

Mr. Warden reports the following section:

Record of well of the North Shore Industrial Company near Woodville Landing.

	Feet.
Wisconsin:	
1. Sand and clay	0–30
Tisbury and Cretaceous?:	
2. White sand, very fine	30–50
3. Gravel, growing coarser	50–94

827. *Record of Wardenclyffe Brick and Tile Company's well, Woodville Landing.*

	Feet.
1. Heavy tenacious clay	0–47
2. Coarse gravel	47–

828. *Record of well of Long Island Railroad at Wading River.*

	Feet.
1. Surface loam	0– 5
2. Coarse white sand, passing below into coarse gravel	5–110

829. *Record of Mrs. De Groat's well near Wading River.*

	Feet.
Recent:	
1. Creek mud, bearing very black water	0–20
Wisconsin:	
2. Hardpan (an iron cemented mixture of clay and stones)	20–38

The pipe broke at a depth of 38 feet and the well was abandoned.

830. *Record of S. W. Wheeler's well near Wading River.*

	Feet.
1. Surface loam	0– 4
Tisbury:	
2. Medium white sand	4–68

Mr. Davis reports that in all his well experience he has not encountered bowlders below the surface between Wading River and Port Jefferson.

831. *Record of Dr. William Carr's well near Center Moriches.*

	Feet.
Wisconsin?:	
1. White sand and gravel, with many stones	0–18
2. Clay, no stones	18–20
3. White sand	20–

832. *Record of Otto Lauraman's well near Center Moriches.*

Wisconsin?:	Feet.
1. Surface loam	0–8
2. Coarse, white, "gravelly" sand	8–18
3. Hard, dry, yellow clay	18–24
4. Coarse sand	24–34

833. *Record of William Hallock's well near Center Moriches.*

Wisconsin?:	Feet.
1. Surface loam	0–5
2. White "gravelly" sand	5–15
3. Hard, dry, yellow clay with an occasional stone	15–20

836. *Record of W. Frank Smith's well near East Moriches.*

Wisconsin and Tisbury:	Feet.
1. Loam	0–2
2. Sand	2–9
3. Gravel	9–17
4. White sand	17–28
5. Quicksand	28–33

838. *Record of Wesley Young's well near South Manor.*

Wisconsin:	Feet.
1. Loam	0–2
2. Sand with stones	2–22

839. *Record of Alfred Steele's well near South Manor.*

Wisconsin:	Feet.
1. Surface loam	0–2
2. Sand	2–15

840. *Record of Benj. Raynor's well near South Manor.*

Wisconsin?:	Feet.
1. Surface loam	0–1
2. Sand	1–22
3. Clay	22–24

Mr. Nichol reports that he drove the pipe several feet into the clay bed and then pulled it up again, and obtained the water from above the clay.

841. *Record of Wallace Raynor's well near South Manor.*

Wisconsin?:	Feet.
1. Black loam	0–3
2. Clay, with occasional layers of sand; no stones	3–15
3. Quicksand	15–19
4. Clay	19–36
5. Coarse sand; water bearing	36–

842. *Record of Porter Howell's well near South Manor.*

Wisconsin?:	Feet.
1. Loam	0–3
2. Sand, with a little clay	3–18

843. *Record of J. W. Nichol's well near Manorville.*

Wisconsin?:	Feet.
1. Surface material	0–6
2. Clay	6–7
3. Coarse white sand	7–12

844. *Record of M. E. Raynor's well near Manorville.*

Wisconsin?:	Feet.
1. Sand	0–12
2. Sandy clay	12–15

The clay in this well is described as being heavier (purer) at increasing depths. Water was found in a thin stratum of sand overlain and underlain by clay.

845. The Long Island Railroad Company report the following partial analysis:

Analysis of water from railroad well at Manorville.

	Parts per million.
Total solids	153.9

846. *Record of Mrs. Jones's well near Manorville.*

Wisconsin?:	Feet.
1. Surface loam	0–3
2. Clay, with occasional layers of water-bearing sand; no stones	3–42
3. Water-bearing sand	42–

Mr. Nichol reports that the clay in stratum 2 was the color of putty, and that he has often encountered it in digging near the surface. He has never found stones in it.

847. Mr. Preston Raynor reports the following sections from two wells on his place:

Record of Preston Raynor's well No. 1, Manorville.

Wisconsin?:	Feet.
1. Loam and yellow sand	0–12
2. Clay; no stones	12–28
3. Fine clean sand	28–32

Record of Preston Raynor's well No. 2, Manorville.

Wisconsin?:	Feet.
1. Black loam	0–3
2. Hard clay; no stones	3–40
3. Sand	40–42

Mr. Raynor reports that he has never found a single stone in his vicinity. Clay is exposed in many of the ponds at low water, and several firms have made brick in this vicinity.

848. Mr. W. H. Beers has reported the following partial record:

Record of Dr. J. H. Darlington's well near Hulse Landing.

Wisconsin:	Feet.
1. Black surface loam	0–2
2. Sandy subsoil	2–3
3. Yellow surface clay	3–4
Transition:	
4. Coarse gravel	4–5
Tisbury:	
5. Fine white beach sand	5–35
Sankaty?:	
6. Dark-red clay, like brick in color	35–43
7. Black sand, like that in sluggish creek ponds	43–60

849. *Record of R. B. Dayton's well near Remsenburg.*

Wisconsin?:	Feet.
1. Loam	0–
2. Sand and gravel	
3. Slate-colored clay	
4. Sand and gravel	–20

850. *Record of Jacob Raynor's well near Speonk.*

Wisconsin?:	Feet.
1. Surface loam and yellow sand	0–5
2. Medium sand	5–21
3. Brown clay	21–25
4. Coarse white sand	25–29

851. *Record of Ellsworth Raynor's well near Speonk.*

Wisconsin?:	Feet.
1. Surface loam and yellow sand	0–4
2. White sand	4–18
3. Clay	18–20
4. White sand	20–26

852. Record same as 850.

854. *Record of C. H. Wells's well near Baiting Hollow.*

Wisconsin and Tisbury:	Feet.
1. Sandy loam	0– 5
2. Fine slightly yellow sand	5– 50
3. Hardpan (a hard stratum which carries no water and is composed of a mixture of clay and quite coarse gravel, seemingly cemented together with iron	50– 51
4. White sand	51–105

Mr. Young says that the record above is duplicated in every well which he has put down in the vicinity of Baiting Hollow. The surface loam is of about the same thickness in each place, while the depth to stratum No. 2 varies from 45 to 60 feet, and the total depth of the wells from 90 to 110 feet. The depth to water varies with the elevation.

Mr. Young gives the following owners of wells in this vicinity, which have similar sections: Howell Benjamin, John B. Warner, Charles Warner, George F. Terry, John W. Fanning, J. C. Young, J. L. Young, Sydney Shaw, E. Hallock, Frank O. Reeves.

855. *Record of Charles Warner's well near Baiting Hollow.*

	Feet.
1. Heavy surface loam	0 – 4.5
Tisbury:	
2. White sand with occasional streaks of clay; no change in coarseness of sand at increasing depths	4.5–100

856. *Record of Howell Sandford's well near Baiting Hollow.*

Tisbury:	Feet.
1. Heavy surface loam	0– 5
2. White sand with occasional streaks of clay	5–104

The material in this well is almost exactly similar to that in No. 855. There is no change in coarseness of sand at increasing depths.

856A. Mr. Terry has furnished the following samples from this well:

Record of Sydney Shaw's well at Centerville.

Tisbury:	Feet.
1–10. Light yellowish outwash sands with a little gravel	0–65

Below 65 feet the well was driven with a closed point and no samples were obtained.

857. *Record of A. Zabriskie's well near West Hampton Beach.*

Wisconsin?:	Feet.
1. Surface loam and yellow sand	0– 4
2. Hardpan (described as a clay mixture of a slaty color whose particles seem to be cemented together)	4– 5
3. White sand	5–20

858. *Record of Hallock & Small's well near Quogue Beach.*

Recent:	Feet.
1. Black marsh deposit	0– 10
Pleistocene:	
2. Medium white sand bearing salt water	10–150
Cretaceous?:	Feet.
3. Green greasy clay	150–180
4. Medium white sand, containing a great deal of lignite	180–225

The sand gradually grew coarser until at 225 feet it was quite coarse. The top of the well is at tide level, and at the time it was drilled the water would rise in a pipe 12 feet above the surface.

Analysis of water from Hallock & Small's well, Quogue Beach.

[By F. E. Chandler, New York, April 25, 1899.]

	Parts per million.
Appearance	Clear.
Color	None.
Odor (heated to 100° F.)	None.
Taste	None.
Chlorine in chlorides	10.00
Equivalent to sodium chloride	16.48
Phosphates (as P_2O_5)	None.
Nitrogen in nitrites	None.
Nitrogen in nitrates	1.20
Free ammonia	.04
Albuminoid ammonia	.02
Total nitrogen	1.27
Total hardness	6.00
Permanent hardness	6.00
Organic and volatile (loss on ignition)	14.00
Mineral matter (nonvolatile) CO_2	52.00
Total solids (by evaporation), dried at 110° C.	66.00
Residue on evaporation	White.

"This is a remarkably pure water, and is entirely free from contamination of every kind."

859. Mr. Asha B. Hallock has furnished the following samples from this well:

Record of A. B. Hallock's well near Quogue.

Sankaty:	Feet.
1. Fragments of shells	135
Cretaceous:	
2. Green sand marl	156–192
3. Coarse white quartz sand with pieces of gray clay and mica	192
4. Very fine dark-gray sand	200–224

Cretaceous—Continued.	Feet.
5. Gray clay	224–230
6. White micaceous sand with fragments of lignitized wood	230–235
7. Very coarse quartz sand with mica and lignitized wood	235–247

The fragmentary material from 135 feet was referred to Dr. W. H. Dall, who reports as follows: "Contains fragments of *Mulina*, *Astarte*, an unidentifiable bivalve, a specimen of *Nassa trivittata* Say and fragments of an echinoderm. This is probably Pleistocene."

860. The well is on high ground and will flow from 1 to 2 gallons a minute.

Record of J. Wendell's well near Quogue.

	Feet.
Pleistocene:	
1. Soil	0– 5
2. Sand with little streaks of clay	5– 90
Pleistocene and Cretaceous:	
3. Clay	90–200
Cretaceous:	
4. Clay with lignite	200–265
5. Coarse white sand, water bearing	265–277

861. The driller, Mr. F. K. Walsh, gives the following record:

Record of Quantuck Water Company's well near Quogue.

	Feet.
Recent:	
1. Bog material	0– 1
Wisconsin and Tisbury:	
2. Loose sand	1– 3
3. Sand, clay, and stones as large as one's head	3– 5
4. Very coarse sand with a little gravel	5–20
5. Very coarse sand and fine gravel with coarse stones	20–40

Analysis of water from Quantuck Water Company's well, Quogue.

[By C. F. Chandler, New York, December 17, 1902.]

	Parts per million.
Appearance	Clear, with very slight sediment on bottom.
Color	None.
Odor (heated to 100° F.)	None.
Taste	None.
Chlorine in chlorides	11.00
Equivalent to sodium chloride	18.15
Phosphates (as P_2O_5)	None.
Nitrogen in nitrites	None.
Nitrogen in nitrates	.07
Free ammonia	.01
Albuminoid ammonia	.03
Total nitrogen	.10
Total hardness	7.99
Permanent hardness	5.33
Organic and volatile (loss on ignition)	4.00
Mineral matter (nonvolatile) CO_2 restored with ammonium carbonate	28.50
Total solids (by evaporation) dried at 110° C.	32.50

"This water is very pure indeed. It shows no signs whatever of contamination of any kind. The water does not contain any appreciable quantity of iron."

863. The pumping station of the Riverhead waterworks is in the Tower rolling mill and the pumps are 1 Knowles vertical triplex water-power pump, capacity 135 gallons per minute; and 1 single-stroke water-power pump in reserve. The water is delivered into a tank having a capacity of 40,000 gallons, which is situated in the tower of the mill.

Mr. John R. Perkins, the former president of the company, reports the following data: "At the depth of 83 feet the first well flowed at the rate of 3 barrels a minute, but the water contained so much iron that the well was sunk deeper, to an approximate depth of 300 feet. The second well was sunk to a depth of 320 feet. Both contained a great deal of iron. The minimum amount pumped is 4,000 gallons an hour; the maximum amount is 8,000."

The driller, Mr. N. W. Davis, gives the following information: "Two wells, one 8 inches (225 feet deep), one 6 inches (305 feet deep). Lignitized wood at 180–200 feet. No clay beds found, but there were occasional beds of clay mixed with sand. Water first flowed over the pipe at 60 feet. The first well for this company was 85 feet deep and flowed a large amount of very chalybeate water. The well was made deeper to obtain a purer water. The flow becomes less at greater depths."

In a letter dated April 25, 1903, he states, regarding the first well: "Sunk an 8-inch well for the Riverhead waterworks 82 feet deep. Formation was sand, dark gravel, thick bed of clay, then sand mixed with little gravel. This yielded about 120 to 130 gallons per minute."

864. Mr. Young reports that the points in all the wells in the vicinity of Riverhead corrode very quickly. Surface wells in the vicinity of Riverhead average a depth of 18 feet.

Record of Yetter & Moore's well near Riverhead.

	Feet.
Wisconsin?:	
1. Dark-brown sand and gravel containing dark-colored stones; the whole discolored by iron	0–16

869. *Record of Capt. Jas. Downs's well near Jamesport.*

	Feet.
1. Clean fine sand, very slightly gray in color	0–18
2. Hard layer	18–19
3. Coarse light-colored sand containing less mica than usual	19–45

870. *Record of J. J. McLaughlin's well near Jamesport.*

	Feet.
1. Brackish water	10–12
2. Fresh water	60–70

872. The Long Island Railroad Company has furnished the following partial analysis, dated February, 1899, of the water from their 20-foot driven well:

Analysis of water of railroad well at Mattituck.

	Parts per million.
Total solids	123.63
Chlorine	9.58

874. *Record of the Thane well near Shinnecock Hills.*

	Feet.
1. White beach sand	0–25
2. Coarse sand to gravel	25–35

Several attempts were made to drive a well on the hilltop near the above well, but too many cobbles were encountered and the holes were abandoned.

875. *Record of C. W. Payne's well near North Sea.*

	Feet
1. Surface loam and yellow sand with some gravel	0– 8
2. Hardpan	8–10
3. Sand and gravel	10–18
4. Coarse sand and gravel	18–25

877. *Record of Reid well near New Suffolk.*

	Feet.
Wisconsin:	
1. Surface loam	0– 3
2. Sand	3– 4
Sankaty?:	
3. Clay	4–88

The clay is said to be distinctly stratified, the strata dipping 30° W.; it is also stained with iron.

879. Mr. George Elliston, engineer, gives the following record for 1902:

"Maximum daily yield (August 29), 733,000 gallons; minimum daily yield (January 10), 114,000 gallons; average daily yield for year, 340,500 gallons; greatest amount pumped from the three wells, 41,000 gallons per hour; this was accomplished without difficulty, indicating a capacity of about a million gallons per day."

The original water level, according to Mr. Darling, constructing engineer, was 27 feet from the surface, while the present level reported by Mr. Elliston is 35 feet.

Analysis of water from well of Southampton Water Company, Southampton.

[By Frazer & Co., New York, June 30, 1903.]

	Parts per million.
Color	Colorless.
Turbidity	Clear.
Sediment	Very slight.
Odor (cold)	None.
Odor (hot)	None.
Total solids	60.000
Loss on ignition (no charring)	25.000
Chlorine	13.580
Nitrogen as free ammonia	0.008
Nitrogen as albuminoid ammonia	0.018
Nitrogen as nitrite	None.
Nitrogen as nitrate	0.800
Temporary hardness	5.000
Permanent hardness	20.000
Total hardness	25.000
Iron	Minute trace.

"The bacteriological examination shows the absence of any bacteria that indicate contamination by human or animal waste. The analysis of this water shows that it is pure and suitable for drinking purposes and general domestic use. The water is soft and does not show evidence of sewage contamination."

When this system was first projected Fresh Pond was very seriously considered as a source of supply. Gagings showed sufficient water and analyses showed no contamination.

880. Mr. Arthur states that the water in this vicinity is found in pockets of clay, which, through surface wash, have become filled with gravel.

Record of Mrs. S. F. McDonald's well near Hampton Park.

	Feet.
Wisconsin:	
1. Coarse white sand	0–34
Sankaty ?:	
2. Clay	34–80

881. *Record of E. G. Whittaker's well near Hampton Park.*

	Feet.
1. Surface loam	0– 2
Sankaty ?:	
2. Very hard clay	2– 82
Jameco ?:	
3. Sand	82–111

At 18 feet clay was taken out which contained the imprint of shells, which, from the description given, were probably pectens.

881A. Mr. Frederick H. Rose reports the following: "Our main spring-water supply seems to come from near sea level, and as we go in and up from the sea the wells deepen from a few feet to perhaps 60, with a few hilltop clay or upper springs. My well here at Water Mill is about 18 feet deep, springs bubbling up through sand and gravelstones."

882. *Record of J. F. Becker's well on Shelter Island, New York.*

	Feet.
1. Loamy clay	0– 9
2. "Silver" sand	9–52

883. *Record of the Ulmer well on Shelter Island, New York.*

	Feet.
Wisconsin:	
1. Loam and clay mixed	0–10
2. Gravel mixed with loam	10–14
Wisconsin and Tisbury:	
3. Hardpan	14–20
Tisbury:	
4. Sand	20–43

884. *Record of John Weber's well on Shelter Island, New York.*

	Feet.
Wisconsin:	
1. Stony, dark-colored, almost red clay	0–12
Tisbury:	
2. Gravel, light in color	12–30
3. Fine beach sand	30–53

At 53 feet a big bowlder was encountered and the well was sunk no farther.

885. *Record of J. N. Stearns's well on Shelter Island, New York.*

	Feet.
Wisconsin:	
1. Red sandy loam	0–15
2. Hard mixture of clay, sand, and gravel	15–27
Sankaty:	
3. Red and blue clay in strata 5 or 6 inches thick, alternating with strata of fine white and red sands	27–35

888. *Record of A. O. Ryder's well on Shelter Island, New York.*

	Feet.
Tisbury and Sankaty:	
1. Ordinary sand in alternate layers of fine and coarse, containing a variety of shells at a depth of 60 feet	0–62

889. The main source of supply at this pumping station consists of a dug well about 70 yards south of the Shelter Island Heights landing. In the bottom of the dug well there is a 6-inch pipe 12 feet long.

Record of well of Shelter Island Heights Association, Shelter Island, New York.

	Feet.
1. Sand	0–18
2. Gravel	18–21

During the summer of 1903 the maximum amount pumped was 5,000 gallons per hour and the average about 4,000 gallons. If the well is pumped at the rate of 10,000 gallons per hour the water becomes brackish from the influx of the sea water.

Five hundred feet from this well a test boring was made in which the following material was encountered:

Record of test boring of Shelter Island Heights Association on Shelter Island, New York.

	Feet.
Wisconsin and Tisbury:	
1. Sand and gravel	0–20
2. Quicksand	20–60
Sankaty:	
3. Red clay	60–

Seven hundred feet west of the first well at the same elevation above the mean high tide and at the same distance from the shore the following section was obtained:

Record of test boring of Shelter Island Heights Association on Shelter Island, New York.

	Feet.
Wisconsin and Tisbury:	
1. Sand and gravel	0–26
2. Quicksand: this was described as a very coarse and fine sand very much like molding sand	26–36
Sankaty:	
3. Tough, red clay, containing no stones as far as penetrated	36–

890. Mr. Havens reports that a group of 18 wells supplies the Manhanset House and the cottages adjacent to it. The amount pumped varies so greatly from day to day, according to the needs of the people in the cottages, and from summer to winter, according to the needs of the hotel, that no average could be given by Mr. Havens, nor could he estimate the maximum or minimum amount pumped.

Record of wells of Manhanset House, Shelter Island, New York.

	Feet.
Wisconsin and Tisbury:	
1. Stony and sandy loam	0– 8
2. Hardpan	8–12
3. White beach sand (coarse and fine mixed, running in places into "sandy gravel")	12–17
4. Hardpan	17–20
5. Quicksand, described by Mr. Havens as a good beach sand containing both black and white mica	20–65

891. *Record of J. M. Wells's well near Greenport.*

	Feet.
1. Dry, yellow clay, containing a few small stones (the auger was twice broken and the fourth hole was begun before the attempt to complete the well was successful)	0–35
2. Medium red sand	35–45

892. Mr. Camerdon, of the Sumpwams Water Company, who was formerly engineer at this place, reports the following section for the first four wells:

Record of Greenport waterworks well, Greenport.

	Feet.
1. Hard, yellow sand and some yellow clay	0–20
2. Fine, white sand, gradually growing coarser	20–48
3. Coarse gravel with pebbles 2 to 3 inches in diameter	48–

In April, 1903, 5 additional wells were sunk, ranging in depth from 28 to 38 feet. As the water from these shallow wells showed a considerable percentage of chlorine a deep test well was sunk. Mr. N. W. Davis, who began this well, reports the following section for the upper 225 feet:

Record of test well of Greenport waterworks, Greenport.

	Feet.
Wisconsin:	
1. Yellow gravelly material	0– 20
Tisbury:	
2. Alternate series of sands and gravel	20–100
Sankaty:	
3. Brown clay similar to that in Sanford's brickyard	100–150
Jameco:	
4. Fine sands	150–225

The well was then completed by Mr. E. K. Hutchinson, the only record kept being a few samples in a test tube preserved by Mr. Fred Klip. These show the following materials:

Record of test well of Greenport waterworks, Greenport.

	Feet.
1. Coarse, yellow sand and gravel (probably glacial)	225–
2. Coarse quartz sand	
3. Coarse quartz pebbles (one granite pebble)	
4. Ferruginous quartz conglomerate	–555
Cretaceous:	
5. White, highly micaceous sand	555–605
6. Fine, white sand	605–612
7. Bright red sand and clay	612–619
8. Brick red clay	619–635
9. Yellow sand and clay	635–640
10. Yellowish-white clay	640–645
11. Salmon colored clay	645–
12. Fine, rather dark quartz sand	
13. Fine, dark-colored sand	–650
14. Coarse quartz sand containing fresh water (Lloyd sand?)	650–670
Pre-Cretaceous:	
15. Schist	670–690

One of the drillers reports that at 665 feet fresh water flowed over the top of the casing in a stream about the size of a pencil; the supply, however, was not deemed sufficient for pumping. Salt water was encountered between 225 and 555 feet.

The Long Island Railroad Company furnished the following analysis of water taken from the mains of the Greenport waterworks, November, 1901:

Analysis of water from Greenport waterworks, Greenport.

	Parts per million.
SiO_2, etc	15.73
$CaCO_3$	11.29
$MgCO_3$	33.17
$CaSO_4$	64.98
$MgSO_4$	27.53
$MgCl_2$	73.02
NaCl	672.03
Total	897.75

893. The Long Island Railroad Company report the following analysis from a 12-foot driven well about 600 or 700 feet from tide water:

Analysis of water from Long Island Railroad well, Greenport.

[April, 1898.]

	Parts per million.
SiO_2, etc	6.33
$CaCO_3$	121.07
$MgCO_3$	33.86
$CaSO_4$	4.79
$MgSO_4$	9.06
$MgCl_2$	13.34
NaCl	9.06
Total	197.51

They also report the following analysis from a 15 to 20 foot dug well 200 to 300 feet from tide water:

Analysis of water from Long Island Railroad well, Greenport.

[October, 1901.]

	Parts per million.
SiO_2, etc	8.04
$CaCO_3$	Traces.
$MgCO_3$	11.11
$CaSO_4$	43.60
$MgCl_2$	19.15
NaCl	65.15
Total	147.05

894. *Record of well at East Marion Life-Saving Station.*

	Feet.
Wisconsin:	
1. Stones embedded in loamy clay and sand	0–38
Wisconsin and Tisbury:	
2. Coarse white sand	38–47
Tisbury:	
3. Coarse white gravel	47–50

Some of the stones taken out of this well weighed at least 1,000 pounds. Many of them had to be blasted in order to be removed. The sand and gravel is reported as dipping about 45° N.

895. *Record of W. F. Furst's well, East Marion.*

	Feet.
Wisconsin:	
1. Surface loam and yellow sand	0–18
2. Hardpan (sand and gravel packed hard)	18–22
Tisbury?:	
3. Gravel and yellow sand	22–35
4. Fine sand	35–

897. Mr. Sanford has furnished the following samples from this well:

Record of Sanford & Son's well at Bridgehampton.

	Feet.
Tisbury?:	
1. Gray micaceous clay, with a few small quartz pebbles	70
Sankaty:	
2. Medium grayish white sand and gravel, with pieces of greenish clay containing fragments of shells	100
Jameco:	
3. Fine to medium orange-yellow sand	105
4. Orange-yellow gravel, apparently identical with that of the old glacial bed on Gardiners Island	110
5. Very fine yellow silt, with orange gravel	112
Cretaceous:	
6. Fine gray sand, with muscovite and lignite	115
7. Medium yellow sand, with fragments of shells	140
8. Gray clayey sand, with fragments of shells	140
9. Greenish gray sandy clay, with fragments of shells	155
10. Very fine dark-gray sand, with some coarse white quartz sand	165
11. Fine light gray sand	190
12. Fine to coarse light gray sand with partially lignitized wood	210
13. Medium white micaceous sand	215
14. Fine light gray sand with lignite	222
15. Lignite and large flakes of muscovite	231
16. Medium white micaceous sand	235
17. White sand, muscovite and lignitized wood	275–287
18. Fragments of iron pyrite	287–288
19. Fine to medium grayish-yellow sand	288–300

Mr. Sanford reports that no record was kept, but that the samples were taken whenever he noticed a change in the material. In the above record the beds, therefore, probably extend from one sample to the next.

900. Mr. J. Wilkes Hedges reports: "From within one-eighth of a mile of the Atlantic Ocean to one and one-half miles north, the depth to water varies from 15 feet to 40 feet. As regards the strata, the first 15 inches is vegetable mold; the next 3 feet subsoil; then a layer of blue clay from 18 inches to 30 inches; then sand to water."

901. Mr. S. Shipperley, foreman for I. H. Ford, has furnished the following samples from this well:

Record of J. K. Morris's well near Sag Harbor.

	Feet.
Wisconsin and Tisbury:	
1. Light-yellow sand and gravel, with a noticeable percentage of erratics, the material coarser in the lower portions	11– 90
2. Orange-yellow quartz sand and gravel	95
Sankaty?:	
3. Grayish yellow, micaceous, silty clay, with a few pebbles	110–113
4. Light-gray, micaceous, silty clay	132
Jameco?:	
5. Fine to very coarse, sharp, white sand, with a few scales of biotite	143–145

903. Mr. Henry F. Cook, president of the Sag Harbor Waterworks Company, reports the following: "In 1888 four wells were sunk to a depth of 40 feet near the pumping plant. These were pumped for a little less than a year, when the water became so red that it did not seem suitable for waterworks use; the wells were then driven to about 100 feet, and after being pumped for a time the water again became red. A large well, 15 by 15, was then sunk about 900 feet south of the pumping station in the edge of a pond, and four 49-foot wells were sunk, with the same result. The driven well system was then abandoned, and the water piped from Ligonee Brook into the large well. Ligonee Brook drains Long Pond, which may be regarded as the real source of the water."

Mr. E. Camerdon, of Sumpwams Water Company, at one time engineer at this point, states that 3 wells were put down in 1894 or 1895, to a depth of 60 feet. No gravel was encountered, the section being entirely white sand. The wells were sunk to 60 feet, not in search of a different water-bearing horizon but to reach sand so coarse that it would not pass the screens.

904. *Record of Fahy Watch Case Company's well, Sag Harbor.*

	Feet.
Tisbury:	
1. Sand and gravel, varying a trifle from fine to coarse	0–182
2. Quicksand	182–

The moment quicksand was encountered in this well driving was discontinued. The water from this well was obtained from four strata at the following depths:

Depths of water-bearing strata in Fahy Watch Case Company's well, Sag Harbor.

	Feet.
1	40
2	90
3	130
4	155–160

The well was tested to its full capacity and yielded 500 gallons per minute. The elevation above high tide is approximately 20 feet, and the water in the well rose to within 14 feet of the surface. The homogeneity of material is indicated by the fact that the same number of feet of pipe was driven daily.

905. Brackish water was found from a few feet below the surface down to 15 and 20; no water was encountered between 20 and 80, when an abundant supply was obtained.

907. *Record of Doctor Benjamin's well at Shelter Island, New York.*

	Feet.
Tisbury and Sankaty:	
1. Very soft, white, medium, coarse sand	0–60

Shells were encountered at 45 feet and continued to the bottom of the well. A fragment of *Venus*, apparently *Venus mercenaria*, has been forwarded by Doctor Benjamin, this being the only specimen saved from this shell-bearing layer.

908. *Record of J. E. Parker's well at Shelter Island, New York.*

	Feet.
Wisconsin:	
1. A hard mixture of clay and sand and a few small stones	0–30
Tisbury:	
2. Sand and gravel in alternate layers, each layer about 8 or 10 feet thick	30–76

909. Mrs. Hattie Conover, daughter of Mr. Uriah White, artesian-well driller, reports: "My father drilled the well at Orient in 1891 for the Orient Manufacturing Company. I am unable to give you any information regarding the well, except that I find one letter referring to it, giving its depth at that time as 406 feet, but the work was continued about three months longer. The water obtained was very salt, and they encountered a hard rock, and had to abandon the well, at a heavy loss."

910. According to Mr. Van Scoy, president of the Easthampton Home Water Company, the supply is derived from three 4-inch wells 70 to 75 feet deep, driven in the bottom of a pit 20 feet in diameter and 25 feet deep. On testing the wells a single well yielded 10,000 gallons per hour and two wells 15,000 and 16,000 gallons. Mr. Joe Seaman, foreman for Mr. W. C. Jaegle, gives the following section:

Record of Easthampton Home Water Company's well near Easthampton.

	Feet.
Wisconsin to Tisbury:	
1. Sand	0– 3
2. Clay	3–10
3. Sand	10–86

The sample, from a depth of 86 feet, which Mr. Seaman has furnished is a light-colored glacial gravel.

Analysis of water from Home Water Company's wells, Easthampton.

[By Fraser & Co., April 15, 1899.]

	Parts per million.
Color	Very slight.
Turbidity	Slight.
Sediment	Slight.
Taste	Palatable.
Odor 1C° C	None.
Nitrogen of free and saline ammonia	0.018
Nitrogen of albuminoid ammonia	.010
Nitrogen as nitrites	None.
Nitrogen as nitrates	None.
Chlorine	12.35
Total solids	43.00
Loss on ignition	11.1
Appearance on ignition	White.
Total hardness	10.0
Temporary hardness	6.0
Iron	Trace.
Bacteriological examination:	
Fermentation test	Negative.
Putrefaction test	Negative.

"The examination indicates that these specimens of water are soft and free from pollution and any excess of organic matter. The water is, therefore, recommended for drinking and general domestic purposes."

911. *Record of United States Army well on Plum Island, New York.*

	Feet.
Wisconsin:	
1. Loam	0– 2.5
2. Sand and large bowlders	2.5–20
Tisbury?:	
3. Fine sand	20 –31
4. Fine sand and gravel	31 –49
5. Coarse sand and fine gravel	49 –89

"We erected a pumping plant here, which has been in operation since 1899."

913. *Record of Long Island Railroad well at Amagansett.*

	Feet.
Wisconsin and Tisbury:	
1. Coarse reddish brown sand, turning to white gravel	0–107

914. *Record of United States Army well at Gull Island, New York.*

	Feet.
1. Loam and sand	0– 30
2. Coarse sand	30– 40
3. Very coarse sand	40– 46
4. Very coarse sand and gravel	46– 52
5. Sand	52– 57
6. Fine quicksand	57– 82
7. Sand and clay	82– 87
8. Gravel and sand	87– 91
9. Coarse gravel and sand	91– 98
10. Fine sand	98–108
11. Light-colored clay	108–112
12. Dark-blue clay, rather oily; when exposed to the air became very hard	112–291

Water was struck at 15 feet, but was very salty; the well flowed at 91 feet, also very salty; no water below 110.

915. *Record of United States Army well at Montauk.*

	Feet.
1. Hardpan (very compact mixture of clay, gravel, and sand)	0–12
2. Bowlders very closely packed together	12–16
3. Coarse reddish brown sand	16–30

Surface water encountered at 9 feet.

Mr. Lockwood put down 3 wells at this place during the Spanish-American war. The second well was similar to the above, but a third well driven some distance from the two former ones had the following section:

Record of United States Army well at Montauk.

	Feet.
1. Sand and gravel	0–15
2. Beach sand	15–27
3. Quicksand	27–37

Mr. Lockwood reports that this well would be exhausted in a minute, and that it took an hour to fill up, so the pipe was pulled up 10 feet, when the well yielded 100,000 to 103,000 gallons a day.

916. The Long Island Railroad Company have furnished the following partial analysis of water from their driven well:

Analysis of railroad well at Montauk.

[July, 1898.]

	Parts per million.
Mineral solids	186.56
Organic	51.3
Chlorine	93.02

917. The following analysis of Fort Pond water was made by the Long Island Railroad Company, September, 1897:

Analysis of Fort Pond water, Montauk.

	Parts per million.
SiO_2, etc.	5.98
$CaCO_3$	16.24
$MgCO_3$	14.71
$CaSO_4$	102.26
$MgSO_4$	47.37
$MgCl_2$	186.72
NaCl	1,216.84
Total	1,590.13

Not used for boilers.

918. The following analysis of Great Pond water was made by the Long Island Railroad Company, September, 1897:

Analysis of water of Great Pond Lake, Montauk.

	Parts per million.
SiO_2	14.71
$CaCO_3$	25.14
$MgCO_3$	33.17
$CaSO_4$	249.15
$MgSO_4$	353.29
$MgCl_2$	614.74
NaCl	4,855.54
Total	6,145.74

Not used for boilers.

919. *Record of Ferguson well on Fishers Island, New York.*

	Feet.
Pleistocene in part:	
1. Gravel, bowlders, and sand	0–260
Cretaceous?:	
2. Blue clay	260–281
Pre-cretaceous:	
3. Rock, light-gray granite	281–485

Salt water was encountered at 201 feet, fresh water at 328, and salt water at 485 feet.

CHAPTER V.

RESULTS OF SIZING AND FILTRATION TESTS.

By W. O. Crosby.

SIZING TESTS.

In the detailed study of the underground water resources of any area it is important to know the extent to which the soil or underlying rock will absorb and transmit water. As both absorption and transmission depend more or less directly on the porosity of the strata, which in turn depends upon the relative size and arrangement of the particles composing them, one method of approaching the problem is to mechanically separate representative samples by means of sieves of known sizes and to construct from the data thus obtained a curve showing at a glance the relative proportions of coarse and fine materials and the degree of uniformity in the composition. From this curve may readily be deduced the effective size and the uniformity coefficient.

The effective size is the size of grain that would allow a sand to have its actual transmission capacity if all the grains were of the same diameter. It may be determined from the dimensions of the mesh of a sieve that will permit 10 per cent of the sample to pass through it, but will retain the other 90 per cent. Thus in any soil 10 per cent of the grains are smaller than effective size and 90 per cent are larger.

The uniformity coefficient is the ratio of the effective size to the size of grain which is larger than 60 per cent of the particles and smaller than 40 per cent.

The actual degree of uniformity of the grains in any sample varies inversely as the coefficient; and hence porosity and transmission must, in general, vary indirectly as the uniformity coefficient and directly as the effective size. Other things being equal, they are low when the coefficient is high, that is, when the grains are diversified in size and the constitution of the sand highly composite, and also when the effective size is small. Otherwise stated, uniformity of grain tends to the maximum values for both porosity and transmission and a high effective size favors transmission, especially by minimizing friction. It will thus be seen that these elements afford a check upon the porosity and transmission values as determined by actual trial in the filtration tests, and that they also afford a means of rating or grading, at least approximately, materials for which filtration tests have not been made.

The determinations of the effective size and uniformity coefficient are, naturally, more accurate for relatively coarse than for fine materials because of the difficulty of separating and measuring minute particles; and hence it is especially desirable to supplement these determinations by filtration tests for fine-grained samples, or for those containing large proportions of quartz flour and clay. Theoretically, it should be possible to deduce a factor or formula for the conversion of sizing results into filtration results, and vice versa; but under the existing limitations of the sizing tests this is manifestly impossible, at least for relatively impalpable materials.

TABLE XII.—*Results of sizing tests.*

Well number.	Commission well number.	Sample number.	Depth.	Effective size.	Uniformity coefficient.	60 per cent finer than—
			Feet.	*Millimeters.*		*Millimeters.*
159	662	1	(a)	.....	.....	0.70
		2	(b)	.....	.....	.138
		3	5.0– 5.5	.....	.....	1.30
		4	6	0.181	23.2	.....
		5	10.0–10.5	.22	5.0	.....
		6	15.0–15.5	.235	6.21	.....
		7	19.0–19.5	.760	3.05	.....
		8	24.5–25.0	.35	4.57	.....
		9	30 –31	.241	7.97	.....
		10	35 –36	.455	5.05	.....
		11	36.5–37	.245	2.82	.....
		12	40.5–41.5	.165	3.58	.....
		15	49 –50	.178	4.78	.....
		16	54.5–55.5	.26	3.92	.....
		17	59.5–60.5	.31	3.61	.....
		18	64 –65	.204	2.84	.....
166	827	1	(c)	.....	.....	.203
		2	3 – 4	.....	.....	.153
		3	5 – 6	.....	.....	.165
		4	10 –11	.....	.....	.145
		5	15 –16	.....	.....	.20
		6	17 –18	.131	7.25	.....
		7	20 –21	.195	3.25	.....
		8	25 –26	.170	5.15	.....
		9	29.5–30.5	.202	2.27	.....
167	828	1	(a)	.....	.....	.125
		2	b3	.....	.....	0.112
		3	5 – 6	.....	.....	.595
		4	10 –11	0.182	3.85	.....

a Surface loam. b Subsoil.

TABLE XII.—*Results of sizing tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth.	Effective size.	Uniformity coefficient.	60 per cent finer than—
			Feet.	*Millimeters.*		*Millimeters.*
167	828	5	15 –16	.198	3.28	.....
		6	20 –21	1.28	2.27	.....
		7	23.5–24.5	2.50	1.32	.....
		8	26 –27	.185	2.49	.....
		9	29.5–30.5	.238	6.72	.....
		10	35 –36	.475	4.00	.....
		11	39 –40	.166	2.29	.....
173	859	1	.5– 1.0	.....	.....	.128
		2	2.0– 2.5	.....	.....	.17
		3	5.0– 5.5	.18	3.44	.....
		4	10 –11	.225	6.22	.....
		5	12.0–12.5	.....	.....	(a)
180	762	1	(b)	.....	.....	.458
		2	(c)	.....	.....	.205
		3	5.0– 5.5	.....	.....	.700
		4	10 –11	.....	.....	.329
		5	12.5–13.5	.....	.....	.379
		6	15 –16	.131	5.88	.....
		7	17 –18	.84	3.18	.....
		8	19 –20	.167	3.89	.....
		9	22 –23	.825	2.16	.....
		10	25 –26	.235	4.57	.....
		11	30 –31	.102	4.16	.....
207	628	1	.5	.....	.....	.32
		2	1.5	.117	5.7	.....
		3	5 – 6	.20	4.0	.....
		4	10 –11	.225	4.0	.....
		5	15 –16	.22	9.71	.....
		6	17 –18	.260	2.56	.....
		7	20 –21	.266	2.11	.....
		8	25 –26	.228	2.76	.....
		9	29 –29.5	.28	3.00	.....
208	638	1	.5	.16	3.25	.....
		2	1.0	.182	3.13	.....
		3	5.0– 5.5	.213	2.72	.....
		4	10 –11	.21	2.33	.....
		5	11 –12	.211	1.34	.....

a Surface loam. b Subsoil. c 63.9 per cent finer than 200 (0.10).

TABLE XII.—*Results of sizing tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth.	Effective size.	Uniformity coefficient.	60 per cent finer than—
			Feet.	*Millimeters.*		*Millimeters.*
208	638	6	12 –13	0.190	2.27	.....
		7	15 –16	.240	2.13	.....
		8	20 –21	.218	3.56	.....
		9	25 –26	.243	1.83	.....
		10	30 –31	.335	8.06	.....
215	627	1	.5	.....	.....	0.56
		2	1.0	.107	5.79	.....
		3	5.0– 5.5	.245	8.16	.....
		4	10 –11	.229	2.25	.....
		5	15 –16	.265	3.32	.....
		6	20.0–20.5	.29	4.2₄	.....
		7	23 –24	.40	7.13	.....
		8	25.0–25.5	.27	2.78	.....
216	639	1	.5	.132	2.71	.....
		2	1.0	.212	4.13	.....
		3	3.0– 3.5	.23	2.39	.....
		4	5.0– 5.5	.245	5.22	.....
		5	9.5–10.5	.229	2.16	.....
		6	15.0–15.5	.247	3.54	.....
		7	20 –21	.26	1.81	.....
		8	24.0–24.5	.24	2.07	.....
217	717	1	.4– 0.5	.119	3.53	.....
		2	1 – 3	.....	.....	.58
		3	5.0– 5.5	.238	2.15	.....
		4	10 –11	.22	2.5	.....
		5	15 –16	.231	7.27	.....
			19.5–20.0	.220	2.66	.....
		6	21 –22	.244	3.8	.....
		7	25 –26	.225	2.71	.....
		8	31 –32	.245	6.53	.....
218	688	1	.5– 0.5	.....	.....	.37
		2	1.5– 1.5	.....	.....	.34
		3	5.0– 5.5	.12	4.58	.....
		4	10 –11	.233	3.86	.....
		5	15 –16	.238	3.82	.....
		6	20 –21	.190	3.36	.....
		7	26 –31	.212	3.82	.....
		8	39 –41	.262	3.36	.....
		9	45 –46	.247	2.15	.....
		10	55 –56	.25	2.48	.....

TABLE XII.—*Results of sizing tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth.	Effective size.	Uniformity coefficient.	60 per cent finer than—
			Feet.	*Millimeters.*		*Millimeters.*
218	688	11	59 –60	0.283	2.86	.....
221	687	1	.4	.....	.....	0.22
		2	1.5	.....	.....	.26
		3	5.0	.....	.....	.435
		4	10 –11	.172	4.65	.....
		5	15 –16	.310	2.99	.....
		6	20 –21	.518	5.79	.....
		7	25 –26	.282	3.72	.....
		8	28 –29	.295	1.88	.....
229	695	1	.3– 0.4	.....	.....	.255
		2	1.5– 1.6	.....	.....	.28
		3	5.0– 5.5	.221	4.12	.....
		4	10 –11	.208	3.66	.....
		5	15 –16	.205	2.24	.....
		6	20 –21	.240	2.63	.....
		7	25 –26	.22	2.14	.....
		8	30 –31	.229	1.49	.....
		9	34 –35	.....	.....	.112
		10	37 –38	.....	.....	.188
235	1090	1	.5– 1.0	.....	.....	.11
		2	2.0– 2.5	.....	.....	.10
		3	5 – 6	.134	4.04	.....
		4	10 –11	.195	2.8	.....
		5	15 –16	.209	3.21	.....
		6	20 –21	.245	7.00	.....
		7	22 –23	.22	7.05	.....
		8	26 –27	.206	3.4	.....
		9	28.0–28.5	.....	.....	.223
294	659	1	.5	.....	.....	.38
		2	1.0	.215	1.47	.....
		3	5.0– 5.5	.192	2.24	.....
		4	10 –11	.224	1.83	.....
		5	15.0–15.5	.233	2.11	.....
		6	20 –21	.212	1.25	.....
		7	23.0–23.5	.245	1.9	.....
		8	25 –26	.243	1.87	.....
		9	30.0–30.5	.250	1.79	.....
296	660	1	.4	.128	2.91	.....
		2	1.0	.20	2.2	.....
		3	5.0– 5.5	.22	2.77	.....

TABLE XII.—*Results of sizing tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth.	Effective size.	Uniformity coefficient.	60 per cent finer than—
			Feet.	*Millimeters.*		*Millimeters.*
296	660	4	10 –11	0.22	2.09	.....
		5	15 –16	.258	2.33	.....
		6	20 –21	.207	1.75	.....
		7	23 –24	.212	1.8	.....
		8	25 –26	.226	2.57	.....
		9	29 –30	.215	2.09	.....
		10	35.0–35.5	.216	2.64	.....
303	607	1	.5– 0.5	.....	.....	0.442
		2	1 – 1	.215	2.68	.....
		3	5.0– 5.5	.229	5.07	.....
		4	10.0–10.5	.221	2.35	.....
		5	15.0–15.5	.23	4.87	.....
		6	20.0–20.5	.206	3.16	.....
		7	25 –26	.22	2.05	.....
		8	30.0–30.5	.25	8.00	.....
		9	35 –36	.218	3.03	.....
		10	40 –41	.23	7.43	.....
308	907	1	.3– 0.4	.....	.....	.28
		2	.8– 1.0	.....	.....	.282
		3	2.5– 3.0	.275	8.73	.....
		4	6 – 7	.231	2.56	.....
		5	10 –11	.347	5.48	.....
		6	15.0–15.5	.274	4.05	.....
		7	20.0–20.5	.264	3.51	.....
		8	25 –26	.268	6.34	.....
		9	30.5–31.5	.36	9.78	.....
		10	32 –33	.228	11.4	.....
		11	35 –36	.257	11.28	.....
		12	40 –41	.26	8.12	.....
		13	44 –45	.22	2.50	.....
		14	50 –51	.216	4.31	.....
		15	55.5–56.5	.226	5.66	.....
310	829	1	.3– .5	.....	.....	.23
		2	1.0– 1.5	.....	.....	.38
		3	4.0– 4.5	.23	3.83	.....
		4	10 –11	.358	4.47	.....
		5	15.0–15.5	.225	3.78	.....
		6	20 –21	.23	3.00	.....
		7	25 –26	.2	3.85	.....
		8	30 –30	.239	6 86	.....

TABLE XII.—*Results of sizing tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth.	Effective size.	Uniformity coefficient.	60 per cent finer than—
			Feet.	*Millimeters.*		*Millimeters.*
310	829	9	35 – 36	0.220	2.48	.....
		10	40 – 41	.220	2.45	.....
		11	45 – 46	.245	4.00	.....
		12	50 – 53	.22	1.82	.....
		13	55 – 56	.30	2.83	.....
		14	60 – 61	.50	4.00	.....
		15	65 – 66	.241	3.53	.....
		16	70 – 71	.60	4.00	.....
		17	75 – 77	.57	5.26	.....
		18	80.5– 81.5	.....	.....	0.37
		19	84.0– 85.5	.247	2.27	.....
		20	90 – 91	.241	2.57	.....
		21	95 – 96	.227	1.78	.....
		22	99.0–100.5	.23	1.65	.....
		23	105 –106	.213	1.7	.....
		24	109 –111	.....	.....	.26
		25	113 –115	1.48	1.96	.....
		26	116 –117	.....	.....	(a)
		27	120 –121	.....	.....	(b)
		28	130 –134	.....	.....	.19
		29	148 –149	.158	1.64	.....
312	619	1	.3– .3	.....	.....	.168
		2	1 – 1	.....	.....	.22
		3	5.0 5.5	.262	17.18	.....
		4	9.5– 10.0	.26	2.27	.....
		5	15 – 16	.24	6.75	.....
		6	20 – 21	1.5	2.67	.....
		7	25 – 27	.182	3.00	.....
		8	30 – 31	.16	1.56	.....
		9	35 – 36	.22	10.1	.....
		10	40 – 41	.23	7.61	.....
		11	43.0– 43.5	.15	5.27	.....
		12	45.0– 45.5	.35	3.71	.....
		13	50 – 51	.19	4.00	.....
		14	55 – 56	.225	6.49	.....
		15	60 – 61	.207	2.00	.....
		16	65 – 66	.22	2.91	.....
		17	70 – 71	.242	3.06	.....
		18	72 – 73	.211	2.6	.....
318	864	1	0.5	.....	.....	.22

(a) 82.6 per cent finer than 200 (0.10).

(b) 77 per cent finer than 200 (0.10).

TABLE XII.—*Results of sizing tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth.	Effective size.	Uniformity coefficient.	60 per cent finer than—
			Feet.	*Millimeters.*		*Millimeters.*
318	864	2	3.0	.....	.....	0.359
		3	8 – 9	0.137	3.0	.....
		4	14 –15	.13	2.7	.....
		5	19 –20	.136	2.71	.....
		6	24 –25	.141	2.73	.....
		7	29 –30	.11	2.82	.....
		8	34 –35	.15	2.53	.....
323	956	1	(a)	.....	.....	.11
		2	1.0– 1.5	.....	.....	.345
		3	4 – 5	.130	3.35	.....
		4	9 –10	.15	3 00	.....
		5	14 –15	.225	3.82	.....
		6	19 –20	.22	4.05	.....
		7	24 –25	.209	2.11	.....
		8	29 –30	.181	3.15	.....
		9	34 –35	.290	2.24	.....
		10	39 –40	.198	1.77	.....
		11	45 –47	.172	3.26	.....
381	697	3	11.5–13.0	.18	2.02	.....
		4	16.5–17.0	.224	1.72	.....
		5	19.0–19.5	.29	3.17	.....
		6	24 –25	.233	2.15	.....
		7	25.5–26.0	.27	11.4	.....
		8	27.0–27.8	.240	2.125	.....
		9	29 30	.187	4.81	.....
		10	34 –34.5	.148	1.34	.....
		11	34.5–35	.169	1.65	.....
		12	37 –38	.169	1.95	.....
382	658	3	9.5–10.5	.212	3.30	.....
		4	10 –11	.237	3.54	.....
		5	15 –16	.228	2.06	.....
		6	20 –21	.216	2.69	.....
		7	25 –26	.28	2.18	.....
		8	29 –30	.238	1.97	.....
		9	31.5–32.3	.168	1.4	.....
		10	34.5–35.0	.189	1.42	.....
		11	35.5–36.0	.124	2.00	.....
		12	40 –41	.196	2.32	.....
		13	41 –42	.138	1.42	.....
		14	46 –47	.198	2.65	.....
		15	50 –51	.282	1.88	.....

(a) Surface.

TABLE XII.—*Results of sizing tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth.	Effective size.	Uniformity coefficient.	60 per cent finer than—
			Feet.	*Millimeters.*		*Millimeters.*
382	658	16	54 –55	0.245	1.51	.....
		17	56 –57	.187	1.26	.....
		18	58 –59	.213	1.46	.....
		19	63 –64	.213	1.62	.....
		20	68 –69	.170	2.03	.....
		21	73 –74	.378	2.07	.....
		22	78 –79	.280	1.48	.....
		23	81 –82	.239	1.76	.....
		24	86 –87	.209	1.45	.....
		25	91 –92	.177	2.06	.....
		26	93 –94	.1	2.04	.....
		27	95 –96.5	.169	1.38	.....
		28	96.5–97.0	.172	1. 6	.....
390	617	1	.5	.....	.....	0.305
		2	1.8– 2.0	.....	.....	.25
		3	2.3– 2.5	.35	3.57	.....
		4	5 – 6	.346	4.05	.....
		5	8.5– 9.0	.26	2.77	.....
		6	10 –11	.22	2.41	.....
		7	15 –16	.22	1.9	.....
		8	16 –17	.24	4.00	.....
		9	20 –21	.236	3.18	.....
		10	25 –26	.22	1.73	.....
		11	29.0–29.8	.141	1.38	.....
391	618	1	0.4	.....	.....	.42
		2	1.5	.....	.....	.35
		3	2.5	.345	6.67	.....
		4	5 – 6	.24	10.83	.....
		5	8 – 9	.14	2.35	.....
		6	10.5–11.5	.247	2.00	.....
		7	14 –15	.251	2.11	.....
		8	16 –17	.211	1.16	.....
		9	18.5–19.0	.31	3.32	.....
		10	23 –24	.39	7.12	.....
		11	26.5–27.5	.159	2.52	.....
		12	31.0–32.3	.17	1.4	.....
400	845	1	0 – 0.8	.....	.....	.225
		2	1.3– 1.5	.41	15.24	.....
		3	2.0– 2.2	.415	6.14	.....
		4	6 – 7	.289	2.01	.....

TABLE XII.—*Results of sizing tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth.	Effective size.	Uniformity coefficient.	60 per cent finer than—
			Feet.	*Millimeters.*		*Millimeters.*
400	845	5	11.0–11.8	0.225	3.02	.....
		6	16 –17	.313	3.04	.....
		7	21 –22	.240	2.06	.....
		8	26 –27	.29	2.76	.....
		9	31 –32	.211	1.96	.....
401	846	1	0 – 0.7	.....	.....	0.63
		2	1.2– 1.6	.....	.....	.3
		3	2.5– 2.7	.38	3.74	.....
		4	5.5– 6.5	.22	4.9	.....
		5	9.5–10.5	.256	3.28	.....
		6	14.5–15.5	.205	2.63	.....
		7	19 –20	.300	7.83	.....
		9	21.5–22.5	.12	3.5	.....
		10	23 –24	.18	3.00	.....
		11	28 –29	.23	2.39	.....
		12	31 –32	.30	6.83	.....
403	847	1	0.2– 0.4	.....	.....	1.38
		2	1.5– 1.9	.29	12.76	.....
		3	3.0– 3.4	.45	11.1	.....
		4	8 – 9	.223	2.24	.....
		5	10 –11	.228	2.63	.....
		6	12 –13	.41	12.7	.....
		7	15 –16	.315	3.1	.....
		8	18 –19	.14	8.15	.....
		9	23 –24	.216	2.5	.....
		10	28 –29	.23	2.7	.....
		11	33.0–33.5	.24	2.04	.....
409	422	1	(a)	.....	.....	3.30
		2	b 1.5	.51	12.16	.....
		3	5	.23	6.52	.....
		4	10	.30	4.4	.....
		5	15	.252	4.48	.....
		6	22	.207	2.32	.....
		7	28	.10	6.8	.....
		8	35	.20	2.05	.....
		9	37	.231	2.1	.....
410	862	1	.2– .6	.161	1.32	.....
		2	1.2– 1.6	.753	8.13	.....
		3	2.3– 2.5	.318	1.8	.....
		4	7 – 8	.23	2.39	.....

a Surface. b Subsoil.

TABLE XII.—*Results of sizing tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth.	Effective size.	Uniformity coefficient.	60 per cent finer than—
			Feet.	*Millimeters.*		*Millimeters.*
410	862	5	12 –13	0.27	4.26	.....
		6	17 –18	.41	11.00	.....
		7	22 –23	.459	7.01	.....
		8	27 –28	.215	2.8	.....
		9	32 –33	.241	5.18	.....
		10	36 –36.8	.232	3.44	.....
416	863	1	0 – 0.6	.....	.....	0.236
		2	1.2– 1.4	.....	.....	2.08
		3	3 2– 3.4	.28	16.07	.....
		4	6 – 7	.28	4.43	.....
		5	11 – 12	.38	6.58	.....
		6	16 – 17	.445	6.14	.....
		7	21 – 22	.41	8.78	.....
		8	26 – 27	.38	6.32	.....
		9	30.9–31.0	.....	.....	.229
		10	31 –32	.365	9.32	.....
		11	36 –37	.33	9.09	.....
		12	41.5–42.5	.365	8.22	.....
418	901	1	.3– .5	.....	.....	.44
		2	2.0– 2.4	.48	13.33	.....
		3	6.5– 8.0	.368	6.71	.....
		4	11 –12	.35	11.14	.....
		5	16 –17	.362	9.67	.....
		6	21 –22	.362	8.01	.....
		7	26 –27	.325	7.88	.....
		8	31 –32	.33	9.09	.....
		9	36.4–36.9	.198	3.8	.....
		10	41 –42	.350	6.91	.....
		11	45 –51	.....	.....	.242
		12	51.0–53.8	.221	1.81	.....
		13	53.8–55.7	.35	2.29	.....
421	906	1	0 – 0.8	.....	.....	.34
		2	2.7– 2.9	.206	5.34	.....
		3	7.5– 8.5	.269	14.5	.....
		4	12.2–13.2	.22	6.27	.....
		5	17.5–18.5	.243	5.1	.....
		6	22.5–23.5	.23	3.91	.....
		7	25.0–25.5	.22	7.73	.....
		8	30 –31	.215	3.02	.....
		9	35 –36	.228	2.76	.....

TABLE XII.—*Results of sizing tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth.	Effective size.	Uniformity coefficient.	60 per cent finer than—
			Feet.	*Millimeters.*		*Millimeters.*
421	906	10	40 –41	0.29	3.62	.....
		11	41 –42	1.30	2.38	.....
		12	45 –46	.229	2.75	.....
		13	50 –51	.220	2.7	.....
		14	54 –55	1.10	2.41	.....
422	959	1	1.7– 2.3	.....	.....	0.136
		2	3.0– 3.5	.....	.....	(a)
		3	8.0– 9.5	.18	7.5	.....
		4	10.5–11.5	.20	4.25	.....
		5	15 –16	.214	7.01	.....
		6	20 –21	.239	2.76	.....
		7	23 –24	.44	10.11	.....
		8	27 –28	.28	3.25	.....
		9	31 –32	.23	4.43	.....
		10	36 –37	.259	3.47	.....
501	909	1	0 – 0.5	.....	.....	.55
		2	2.5– 3.5	.243	3.00	.....
		3	5 – 7	.235	4.04	.....
		4	10 –12	.205	2.88	.....
		5	15 –16	.780	5.0	.....
		6	20 –21	.193	2.33	.....
		7	25 –27	.229	2.9	.....
		8	30 –31	.260	5.19	.....
		9	35 –36	.310	2.9	.....
		10	40 –41	.235	2.68	.....
		11	45 –46	.208	1.61	.....
		12	50 –51	.210	3.33	.....
		13	55 –56	.178	1.40	.....
502	955	1	.5– 1.0	.....	.....	.25
		2	1.5– 2.0	.....	.....	.725
		3	2.5– 3.0	.235	13.62	.....
		4	4.5– 5.5	.64	6.64	.....
		5	6 – 7	.45	11.56	.....
		6	10 –11	.215	10.00	.....
		7	15.0–17.5	.219	5.02	.....
		8	20 –22	.23	10.00	.....
		9	25.0–26.5	.27	7.89	.....
		10	30 –32	.234	11.54	.....
		11	35 –36	.365	8.36	.....
		12	41 –42	.218	5.83	.....

(a) 61 per cent finer than 0.10.

TABLE XII.—*Results of sizing tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth.	Effective size.	Uniformity coefficient.	60 per cent finer than—
			Feet.	*Millimeters.*		*Millimeters.*
502	955	13	45.0– 46.5	0.54	4.91	.....
		[a] 14	50 – 52	.....	.....	.....
		15	55 – 57	2.00	1.26	.....
		16	59 – 61	.....	.....	0.535
		17	64.5– 65.5	.42	2.26	.....
		18	70.0– 71.5	.365	2.66	.....
		19	75 – 76	.42	3.52	.....
		20	80 – 81	.225	4.00	.....
		21	83	2.21	1.35	.....
		22	85 – 86	.63	4.41	.....
		23	90.0– 90.5	.38	9.37	.....
		24	95.0– 95.5	.22	5.45	.....
		25	100.0–105.5	.37	5.14	.....
		26	101 –102	.23	2.26	.....
		27	104.5–105.0	.219	1.89	.....
		28	109 –110	.20	1.65	.....
		29	114.5–115.5	.185	1.52	.....
		30	120 –121	.218	1.66	.....
		31	124.5–125.5	.218	1.66	.....
		32	129.5–131.0	.226	1.61	.....
		33	132.5–135.5	.233	4.68	.....
506	1142	1	0 – 1.5	.....	.....	.23
		2	1.8– 2.2	.275	7.27	.....
		3	3 – 6	.226	4.56	.....
		4	10 – 11	.51	7.25	.....
		5	15 – 16	.29	3.72	.....
		6	20 – 21	.48	6.04	.....
		7	25 – 26	.50	4.6	.....
		8	30 – 32	.23	3.91	.....
		9	35 – 37	.40	7.75	.....
		10	40 – 41	.35	5.71	.....
		11	45. – 46	.335	5.08	.....
		12	50 – 51	.275	3.42	.....
		13	55 – 56	.23	9.13	.....
		14	60 – 61	.22	2.09	.....
		15	65 – 66	.218	1.51	.....
		16	70 – 71	.218	1.82	.....
		17	75 – 76	.20	2.25	.....
		18	79.5– 80.5	.19	1.21	.....
569	849	1	.2– .3	.....	.....	.41

[a] This sample too small to analyze.

TABLE XII.—*Results of sizing tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth.	Effective size.	Uniformity coefficient.	60 per cent finer than—
			Feet.	*Millimeters.*		*Millimeters.*
569	849	2	2.0– 2.4	.....	.....	0.605
		3	4.0– 4.5	0.239	7.66	.....
		4	10 –11	.27	3.89	.....
		5	11 –12	.27	3.89	.....
		6	15 –16	.34	2.91	.....
		7	20.5–21.5	.26	4.12	.....
		8	25 –26	.238	2.48	.....
		9	30 –31	.49	3.67	.....
574	865	1	0.5– 1.0	.....	.....	.216
		2	1.7– 2.3	.....	.....	.205
		3	2.7– 3.3	.....	.....	.23
		4	5 – 6	.31	2.97	.....
		5	9 –10	.30	10.67	.....
		6	15 –16	.54	6.3	.....
		7	20 –21	.375	2.47	.....
		8	25 –27	.26	3.9	.....
		9	30 –32	.65	4.06	.....
		10	35.0–36.5	.213	2.07	.....
		11	37.5–38.0	.144	2.19	.....
		12	40 –41	.242	2.4	.....
		13	45 –46	.228	4.17	.....
		14	50.5–53.0	.52	4.33	.....
		15	52.4–52.6	.11	7.82	.....
		16	55 –58	.105	8.39	.....
		17	58.5–59.5	.118	3.31	.....
		18	60.5–61.5	.220	1.85	.....
		19	63 –64	.19	2.8	.....
		20	65.5–66.5	.65	1.77	.....
		21	70.0–72.5	.20	2.9	.....
		22	74.5–75.5	.22	1.66	.....
		23	80 –81	.232	2.41	.....
		24	84 –85	.332	1.78	.....
575	908	1	.5– 1.0	.145	7.93	.....
		2	1.5– 2.0	.62	6.05	.....
		3	3 – 4	.33	6.06	.....
		4	6 – 7	.37	7.03	.....
		5	10 –11	.363	7.71	.....
		6	15 –16	.529	7.37	.....
		7	20 –21	.213	2.63	.....
		8	24 –25	.195	1.13	.....

TABLE XII.—*Results of sizing tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth.	Effective size.	Uniformity coefficient.	60 per cent finer than—
			Feet.	*Millimeters.*		*Millimeters.*
575	908	9	27.0-28.5	0.215	1.08	.....
		10	31 -32	.218	1.09	.....
		11	35 -37	.218	1.3	.....
		12	40.5-41.5	.228	1.5	.....
635	743	1	0 - 0.5	.....	.....	0.605
		2	.5- 1.0	.....	.....	2.00
		3	1 - 3	.53	6.51	.....
		4	5 - 6	.38	7.37	.....
		5	10 -11	.341	7.68	.....
		6	15 -16	.398	4.22	.....
		7	19 -20	.28	4.57	.....
		8	24 -25	.38	2.6	.....
637	729	1	(a)	.....	.....	1.13
		2	.5- 1.0	.....	.....	.80
		3	1 - 3	.308	8.08	.....
		4	5 - 6	.358	8.1	.....
		5	10 -11	.435	7:13	.....
		6	15 -16	.25	4.8	.....
		7	20 -21	.23	2.7	.....
		8	24 -26	.345	2.43	.....
		9	29	.338	5.47	.....
639	826	1	(a)	.....	.....	.74
		2	.5- 2.0	.156	6.73	.....
		3	5 - 6	.259	4.02	.....
		4	10 -12	.434	4.61	.....
		5	15 -16	.219	4.93	.....
		6	20 -21	.365	2.8	.....
		7	25 -26	.42	6.21	.....
		8	30 -31	.22	1.59	.....
		9	35 -36	.209	1.55	.....
		10	40 -41	.314	3.12	.....
		11	45 -46	.265	3.21	.....
		12	50 -51	.34	1.76	.....
		13	55 -56	266	2.03	.....
		14	60 -61	.22	1.93	.....
		15	65 -66	.37	2.51	.....
		16	70 -71	.382	2.49	.....
		17	75 -76	.281	3.47	.....
		18	80 -81	.231	2.86	.....
		19	85 -86	.46	2.72	.....

a Surface.

TABLE XII.—*Results of sizing tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth.	Effective size.	Uniformity coefficient.	60 per cent finer than—
			Feet.	*Millimeters.*		*Millimeters.*
639	826	20	87.0– 87.5	0.125	1.72	.....
		21	91 – 92	.....	.....	0.182
694	861	1	0.3	.....	.....	.5
		2	1.0– 1.5	.....	.....	.39
		3	5.0– 5.5	.224	2.63	.....
		4	10.0– 10.5	.22	15.23	.....
		5	15 – 16	.195	3.33	.....
		6	20 – 21	1.10	3.19	.....
		7	30.0– 30.5	.3	5.67	.....
		8	35.5– 35.5	.33	2.73	.....
		9	40.0– 40.5	.23	3.00	.....
		10	45.0– 45.5	.214	1.54	.....
		11	50.0– 50.5	.238	5.25	.....
		12	55 – 56	.222	3.47	.....
		13	60.0– 60.5	.19	1.37	.....
		14	65.0– 65.5	.224	2.28	.....
		15	69.0– 69.5	.229	2.1	.....
		16	75.0– 75.5	.242	1.9	.....
		17	80.0– 80.5	.208	1.25	.....
		18	85.0– 85.5	.209	1.82	.....
		19	90.0– 90.5	.200	1.17	.....
		20	95.0– 95.5	.22	1.59	.....
		21	100.0–100.5	.18	1.23	.....
		22	101.5–102.0	.....	.....	.22
695	843	1	.5	.....	.....	.4
		2	1.5– 2.0	.....	.....	.6
		3	5.0– 5.5	.22	4.64	.....
		4	10.0– 10.5	.27	1.73	.....
		5	15.0– 15.5	.22	4.5	.....
		6	20.0– 20.5	.22	2.73	.....
		7	25 – 26	.42	7.33	.....
		8	30.0– 30.5	.23	2.52	.....
		9	35 – 36	.235	3.83	.....

FILTRATION TESTS.

Filtration tests were made with columns of carefully packed material, 6 inches long and one ten-millionth of an acre in section, under a 5-foot head of water. Recently boiled water of normal room temperature was used. Before beginning the filtration test with a sample the air was expelled by admitting water from a burette slowly at the bottom of the column, and the volume of water thus required to fill the sand was carefully measured. This volume expressed in cubic centimeters and also in percentages constitutes the porosity determination.

The upper end of the tube was then connected with the 5-foot head of water for the filtration test. Water was allowed to flow unmeasured for several minutes until the finer sand particles should have time to adjust themselves and until any residuum of air left in the sand should have been dissolved out; the flow was then carefully measured for five minutes and multiplied by 12 to get the rate per hour.

Under the conditions of the tests it is, obviously, impossible to reproduce the structure of the material as it existed in the ground; and yet this structure—the mode of association and arrangement of the grains of varying sizes—must profoundly influence the filtration rate. This is, probably, the most serious limitation of the filtration tests; for while we may fairly assume that the material in the ground is closely packed (hard-packed), we have, in general, or with ordinary boring samples, no means of knowing whether it is a homogeneous mixture or, as must commonly be the case, distinctly laminated, coarse, pervious layers alternating with fine, impervious layers, in a way to insure the maximum flow in a horizontal direction. If a general assumption must be made, it were, doubtless, most conservative to assume the horizontal flow as greater and the vertical flow as less than the filtration rate, which may be, in many cases, an approximate mean.

TABLE XIII.—*Results of filtration tests.*

Well number.	Commission well number.	Sample number.	Depth (feet).	Porosity.		Filtration: Cm.³ per hour.
				Cm.³.	Per cent.	
148	1204	9	30–31	17	32	960
		10	35–36	17	32	672
		11	36–37	14.5	27.3	2,880
		12	44–45	17	32	5,520
		13	50–51	16.5	31.1	540
		14	55–56	18	33.9	960
		15	62–63	16	30.1	4,320
		16	67–68	14.5	27.3	3,144
		17	74–75	17.5	33	3,780
		18	82–83	19	35.8	5,100
		19	88–89	14.5	27.3	2,204
		20	95–96	17	32	828
303	607	5	15 –15.5	18	33.9	6,180
		6	20 –20.5	18	33.9	2,040

TABLE XIII.—*Results of filtration tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth (feet).	Porosity.		Filtration: Cm.³ per hour.
				Cm.³.	Per cent.	
303	607	7	25 –26	19	35.8	4,200
		8	30 –30.5	17	32	7,380
		9	35 –36	18	33.9	2,616
		10	40 –41	15.5	29.2	3,660
308	907	11	35–36	15	28.3	4,800
		12	40–41	16.5	31.1	6,240
		13	44 –45	20	37.7	7,440
		14	50 –51	15.5	29.2	3,360
		15	55.5–56.5	17	32	7,560
310	829	8	30 –30	16.5	31.1	5,640
		9	35 –36	16	30.1	3,540
		10	40 –41	18	33.9	4,620
		11	45 –46	17	32	8,760
		12	50 –53	24	45.2	4,920
		13	55 –56	19.5	36.7	14,400
		14	60 –61	19.5	36.7	17,940
		15	65 –66	18.5	34.9	10,200
		16	70 –71	21	39.6	20,880
		17	75 –77	15	28.3	21,840
		18	80.5–81.5	26	49	84
323	956	6	19 –20	16	30.1	4,080
		7	24 –25	16.5	31.1	2,136
		8	29 –30	15	28.3	936
		9	34 –35	21	39.6	14,880
		10	39 –40	12.5	23.5	2,640
		11	45 –47	14	26.4	636
382	[a] 658	3	9.5–10.5	24	47	624
		4	10 -11	15	29.4	3,960
		5	15 –16	22	43.1	9,840
		6	20 –21	11.5	22.5	4,740
		7	25 –26	21	41.1	9,120
		8	29 –30	12	23.5	2,940
		9	31.5–32.3	22	43.1	852
		10	34.5–35.0	17.5	34.3	80,000
400	845	3	2 – 2.2	18	33.9	7,200
		4	6 – 7	35	66	11,880
		5	11 –11.8	18.5	34.9	4,680
		6	16 –17	18	33.9	8,280
		7	21 –22	17.5	33	4,320

[a] Wells 658 and 846 have porosity percentages reckoned on basis of 51 cm.³ capacity for filtration tube; all others 53 cm.³ capacity.

TABLE XIII.—*Results of filtration tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth (feet).	Porosity—		Filtration: Cm.³ per hour.
				Cm.³.	Per cent.	
400	845	8	26 –27	17.5	33	8,340
		9	31 –32	19.5	36.7	3,540
401	[a]846	3	2.5– 2.7	12.5	24.5	1,200
		4	5.5– 6.5	13.5	26.4	3,300
		5	9.5–10.5	17	33.3	4,740
		6	14.5–15.5	17	33.3	1,740
		7	19 –20	16	31.3	9,420
		9	21.5–22.5	14.5	28.4	444
		10	23 –24	13.5	26.4	288
		11	28 –29	19	37.2	2,880
		12	31 –32	17	33.3	8,280
403	847	5	10 –11	16	30.1	4,680
		6	12 –13	16	30.1	16,680
		7	15 –16	17.75	33.4	9,420
		8	18 –19	14	26.4	12,960
		9	23 –24	18.5	34.9	4,380
		10	28 –29	16.5	31.1	5,340
410	862	3	2.3–22.5	20	37.7	3,060
		4	7 – 6	16	30.1	2,700
		5	12 –13	12.5	23.5	6,060
		6	17 –18	13.5	25.4	8,760
		7	22 –23	13	24.5	7,740
		8	27 –28	15	28.3	2,880
		9	32 –33	23	43.3	3,180
		10	36.0–36.8	16.5	31.1	6,000
418	901	8	31 –32	16.5	31.1	13,260
		9	36.4–36.9	14.5	27.3	1,944
		10	41 –42	17.5	33	13,704
		11	45 –51	23	43.3	2,880
		12	51.0–53.8	20	37.7	7,860
		13	53.8–55.7	36	67.9	21,840
421	906	9	35 –36	18.5	34.9	9,480
		10	40 –41	18	33.9	15,420
		11	41 –42	24	45.2	60,000
		12	45 –46	21	39.6	12,504
		13	50 –51	20.5	38.6	11,340
		14	54 –55	19	35.8	52,800
422	959	8	27 –28	16.5	31.1	11,340
		9	31 –32	16	30.1	8,400

[a] Wells 658 and 846 have porosity percentages reckoned on basis of 51 cm.³ capacity for filtration tube; all others 53 cm.³ capacity.

TABLE XIII.—*Results of filtration tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth (feet).	Porosity—		Filtration: Cm.³ per hour.
				Cm.³.	Per cent.	
422	959	10	36 –37	17	32	12,060
454	960	1	5 – 6	16.5	31.1	6,000
		2	8 –10	19.5	36.7	3,480
		3	21.1–25.0	18	33.9	3,480
		4	37 –40	18	33.9	18,240
		5	41 –52	17	32	1,980
495	1272	1	0.5– 1.0	16.5	31.1	3,360
		2	1.5– 2.0	15	28.3	9,720
		3	5 – 6	16	30.1	17,400
		4	10 –11	11	20.7	2,940
		5	15 –16	17.5	33	7,260
		6	20 –21	17	32	8,940
		7	24 –25	18	33.9	7,260
		8	29 –30	19.5	36.7	8,760
		9	30 –31	20	37.7	1,080
		10	32 –33	16	30.1	2,160
		11	34 –35	24	45.2	1,500
		12	40 –41	20.5	38.6	852
		13	45 –46	20	37.7	1,560
		14	48 –49	.....	.....	(a)
		15	60 –61	26	49	408
		16	63 –65	20.5	38.6	756
		17	65.5–67.5	23	43.3	372
		18	70 –71	21.5	40.5	251
697	1087	3	5.0– 5.5	22	41.5	7,320
		4	10 –12	17	32	7,860
		5	15 –16	16.5	31.1	7,560
		6	20 –21	21.5	40.5	6,000
		7	25 –26	16.5	31.1	8,940
		8	29 –30	17	32	5,580
698	1088	4	10.0-10.5	16	30.1	60,600
		5	15.0–15.5	15.5	29.2	10,200
		6	20.0–20.5	16	30.1	10,620
		7	25.0–25.5	17	32	6,600
		8	30.0–30.5	16	30.1	9,360
707	1141	3	3 – 5	13.5	26.4	4,140
		4	5 –21	16	30.1	1,320
		5	21 –25	16	30.1	8,760
		6	25 –30	15.5	29.2	15,360

a Does not filter.

TABLE XIII.—*Results of filtration tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth (feet).	Porosity—		Filtration: Cm.³ per hour.
				Cm.³.	Per cent.	
707	1141	7	30– 35	16	30.1	42,960
		8	35– 40	16	30.1	10,560
		9	40– 45	18	33.9	58,200
		10	45– 50	18.5	34.9	12,660
		11	50– 55	15.5	29.2	12,960
		12	55– 60	18	33.9	9,840
		13	60– 65	14	26.4	15,180
		14	65– 70	15.5	29.2	8,700
		15	70– 78	16	30.1	9,360
		16	78– 81	19	35.8	6,960
		17	81– 85	17	32	8,280
		18	85– 88	18	33.9	5,760
		19	88– 92	20.5	38.6	10,800
		20	92– 97	17	32	21,420
		21	97–100	17	32	9,240
		22	100–103	20	37.7	5,640
708	1195	4	5– 10	14.5	27.3	2,820
		5	10– 15	13.5	26.4	6,828
		6	15– 20	17	32	8,040
		7	25– 28	16.5	31.1	7,940
		8	29– 30	16	30.1	3,744
		9	30– 35	14.5	27.3	8,280
		10	35– 40	17	32	11,040
		11	40– 44	14.5	27.3	5,796
729	1198	4	9– 10	15.5	29.2	6,420
		5	14– 15	14.5	27.3	4,020
		6	19– 20	13	24.5	3,984
		7	24– 25	15	28.3	8,520
		8	29– 30	16.5	31.1	9,360
		9	34– 35	20	37.7	9,960
		10	39– 40	17	32	10,920
		11	44– 45	18	33.9	8,760
731	1200	3	4– 5	13.5	25.4	9,240
		4	9– 10	16	30.1	9,780
		5	14– 15	14.5	27.3	7,260
		7	24– 25	16.5	31.1	10,620
		8	29– 30	17	32	7,560
		9	34– 35	16.5	31.1	7,260
		10	39– 40	17	32	3,060
		11	44– 45	17	32	10,740

TABLE XIII.—*Results of filtration tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth (feet).	Porosity—		Filtration: Cm.³ per hour.
				Cm.³.	Per cent.	
731	1200	12	49– 50	16.5	31.1	10,980
		13	54– 55	15.5	29.2	6,480
732	1202	4	9– 10	14.5	27.3	3,840
		5	14– 15	17.5	33	1,800
		6	19– 20	17.5	33	27,000
		7	24– 25	17	32	8,820
		8	29– 30	17.5	33	1,860
		9	34– 35	17	32	19,800
755	1206	4	9– 10	16.5	31.1	840
		6	19– 20	14	26.4	14,520
		8	29– 30	17	32	3,000
		10	39– 40	17	32	3,240
		12	49– 50	15.5	29.2	4,140
		14	59– 60	16	30.1	7,980
		16	69– 70	18	33.9	5,580
		18	79– 80	19.5	36.7	2,700
		20	89– 90	21	39.6	4,860
778	1145	3	4– 5	19	35.8	9,360
		6	19– 20	19.5	36.7	7,200
		9	34– 35	18.5	34.9	7,320
		12	49– 50	20.5	38.6	5,340
		15	64– 65	19.5	36.7	6,540
		18	79– 80	19	35.8	3,480
		21	94– 95	19.5	36.7	3,960
		24	109–110	19.5	36.7	6,360
		27	124–125	21	39.6	2,700
		30	134–135	22	41.5	54
		33	149–150	20.5	38.6	4,344
781	1169	4	9– 10	18	33.9	7,620
		5	14– 15	21	39.6	8,580
		6	19– 20	16	30.1	9,540
		7	24– 25	19	35.8	8,940
		8	29– 30	18.5	34.9	10,080
		9	34– 35	20.5	38.6	14,640
		10	39– 40	22	41.5	5,280
		11	44– 45	22	41.5	14,700
		12	49– 51	20.5	38.6	13,380
796	1214	4	5– 10	20	37.7	3,300
		6	15– 20	19.5	36.7	6,360

TABLE XIII.—*Results of filtration tests*—Continued.

Well number.	Commission well number.	Sample number.	Depth (feet).	Porosity—		Filtration: Cm.³ per hour.
				Cm.³.	Per cent.	
796	1214	8	25–30	20	37.7	5,640
		10	35–40	19.5	36.7	3,060
		12	45–50	20.5	38.6	3,480
		14	55–57	19	35.8	3,600
798	1215	4	5–10	17	32	9,180
		6	15–20	17	32	7,200
		8	25–30	16.5	31.1	6,780
		10	35–40	17.5	33	5,940
		12	45–50	18.5	34.9	5,280
		14	55–60	17.5	33	10,320
		16	65–70	15	28.3	4,440
		18	75–80	17	32	3,240
		20	85–90	16	30.1	2,736

CHAPTER VI.

THE SURFACE STREAMS OF LONG ISLAND.

By Robert E. Horton.

CHARACTER OF LONG ISLAND STREAMS.

In a region of moderate rainfall a sloping valley which is continuously depressed below the ground-water horizon will contain a perennial stream. If the bed of the valley is in some degree impervious, the stream may continue over regions where the ground-water horizon lies at greater depth, or a perennial stream may be fed from natural or artificial surface storage in lakes in impervious basins lying above the general ground-water bed.

In general, however, a stream whose channel lies above the ground-water horizon will be intermittent, and such an intermittent stream may flow under the following conditions: (*a*) Whenever the ground-water plane, in its periodic fluctuation, rises above the topographical elevation of the stream bed; (*b*) whenever the surface supply from rainfall or melting snow is in excess of the amount absorbed by the soil, so that surface run-off takes place.

The great sand and gravel deposits of Long Island afford streams differing in character from those generally found elsewhere in New York and in the New England States, where rock is generally found near the surface.

Many of the Long Island catchment areas may be described as narrow strips extending inland from the south shore of the island, having in many cases a nearly uniform slope of about 20 feet per mile. The soil is coarse grained and permeable, and the ground-water table slopes toward the south shore at a rate of 10 or 12 feet per mile. In other words, the ground-water table approaches the surface at a rate of 8 to 10 feet per mile, and in the first few miles back from the coast the ground water lies very near the general ground surface. The general ground surface and ground-water planes intersect at tide water. The stream valleys are flat bottomed and generally marshy, and are depressed a few feet below the general surface.

The bed of the stream valley, running parallel to the general slope of the surface, intersects the ground-water horizon a short distance inland, commonly 1 to 5 miles, and it is at this point of intersection that the surface streams usually have their visible sources.

The level of the ground water is subject to periodic fluctuations of a few feet; hence the point of its intersection of the stream valley is not invariable, but may recede and advance with the season or with the rise and fall of ground water, as was observed by the writer in 1903. These conditions are illustrated for an ideal stream in figs. 68 and 69. From tide water to the point A of intersection of the stream valley with the minimum ground-water level the stream is perennial.

From A to B, covering the range of fluctuation of ground water, the stream is intermittent, having its source at A in times of low ground water and at B in times of high ground water. The distance A–B is usually slight. Above the point B

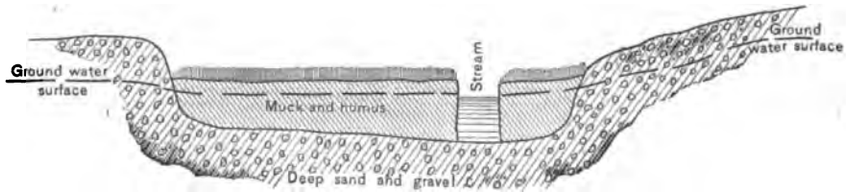

FIG. 68.—Long Island marsh stream valley.

the stream flows only in times of freshets, when supplied by surface run-off. There are also flats and glacial depressions, as at C, from which no surface run-off ever takes place.

If for any reason, as, for example, the existence of an outcrop of impervious material in the gravel slope, a permanent stream supply is brought to the surface at some point in the catchment basin above the point B, a disappearing stream may result, similar in character to streams from the Rocky Mountains which are lost in the porous soils of the Great Plains, but of course very much smaller. A number of such streams arising in springs have been observed.

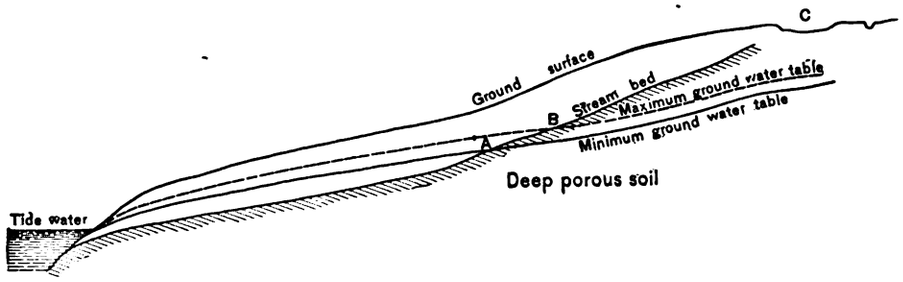

FIG. 69.—Ideal Long Island stream profile.

UTILIZATION OF LONG ISLAND SURFACE STREAMS.

The streams are too small in volume and declivity to afford extensive water powers.

In constructing the South Shore highway it was necessary to build earth dikes across the flat stream valleys, and these dikes have been utilized in many instances as mill dams, the absence of severe freshets on these streams making large overflow or wasteway channels unnecessary.

The second important use of the surface streams has been in the formation of numerous private ponds for landscape effect in private parks and for water supply for estates and summer residences.

Certain streams are utilized in cranberry culture and to a limited extent for irrigation of truck lands.

The streams and ground waters are utilized as sources of water supply for Brooklyn and for the extensive summer-resort population at towns along the south shore of the island.

THE WATER SUPPLY OF BROOKLYN, N. Y.[a]

Brooklyn was incorporated as a city in 1834; it then contained a population of 23,000. The question of constructing a system of public water supply was almost continually agitated from this date until 1856, when the construction of a waterworks system was undertaken, including supply ponds on a number of streams near Brooklyn, on the south shore of Long Island.

The original works were completed in 1862, and comprised six supply ponds receiving the drainage from an aggregate catchment area of 65.6 square miles, including additions made to the waterworks previous to their later extension eastward. The cost of the original works was $4,200,000.

Previous to the construction of the municipal waterworks, franchises had been secured and small supplies had been developed by a number of private water companies.

In 1889 the extension of the waterworks eastward from Rockville Center to Massapequa was undertaken. The extension of the system added a drainage area of 88.5 square miles, making the total area tributary to the complete system 154.1 square miles.

The names and capacities of the supply ponds in the old and new systems are given in the following tables, together with the population and annual consumption of water from the municipal system of Brooklyn:[b]

Area, elevation, and capacity of supply ponds for Brooklyn waterworks.

Name.	Elevation of waste weir above tide.	Area at waste-weir elevation.	Available storage capacity.
	Feet.	*Acres.*	*U. S. Gallons.*
Baisley's	9.569	40.0	41,940,000
Springfield	5.078	7.34	7,199,000
Simonson's	16.995	8.75	9,879,000
Clear Stream	13.194	1.07	977,500
Watt's	6.53	3.43	3,750,000
Valley Stream	14.583	17.78	20,850,000
Pine's	13.682	8.0	9,046,000
Hempstead	12.216	23.52	26,900,000
Smith's	5.086	27.25	41,580,000
Millburn	6.6	13.63	11,100,000
East Meadow	7.7	16.15	18,830,000
Newbridge	8.5	8.90	11,428,000
Wantagh	9.7	10.14	15,030,000
Seaman's	14.9	14.78	28,990,000
Massapequa	11.12	14.55	16,990,000

[a] See The Brooklyn Water Works and Sewers, memoir by James P. Kirkwood, 1857; also History and Description of the Water Supply of the City of Brooklyn, by I. M. De Varona, 1896.

[b] From report of I. M. De Varona, 1896.

Population of Brooklyn and daily water consumption per capita.

Year.	Population.	Population dependent on Brooklyn water supply.	Average daily consumption, Brooklyn water supply.		Consumption per capita per day, Brooklyn water supply.
			U. S. gallons.	*Second-feet.*	*U. S. gallons.*
1860	266,714	266,714	3,293,000	5.004	12.3
1861	272,350	272,350	4,064,000	6.299	14.9
1862	278,106	278,106	5,026,000	7.790	18.1
1863	283,983	283,983	6,494,000	10.065	22.9
1864	289,985	289,985	8,105,000	12.562	27.9
1865	296,112	296,112	9,232,000	14.310	31.2
1866	313,852	313,852	10,908,000	16.907	34.8
1867	332,656	332,656	12,351,000	19.144	37.1
1868	352,585	352,585	15,709,000	24.349	44.6
1869	373,710	373,710	17,629,000	27.325	47.2
1870	396,099	396,099	18,654,000	28.914	47.1
1871	412,403	412,403	19,351,000	29.994	46.9
1872	429,380	429,380	22,714,000	35.207	52.9
1873	447,054	447,054	24,875,000	38.556	55.6
1874	465,455	465,455	24,755,000	38.370	53.2
1875	484,616	484,616	27,150,000	42.082	56.0
1876	500,014	500,014	28,109,000	43.569	56.2
1877	515,903	515,903	30,345,000	47.035	58.8
1878	532,296	532,296	30,507,000	47.286	57.3
1879	549,211	549,211	32,912,000	51.014	59.9
1880	566,663	566,663	30,745,000	47.655	54.3
1881	584,659	584,659	32,722,000	50.719	56.0
1882	601,103	601,103	34,623,000	53.665	57.6
1883	617,517	617,517	36,149,000	56.031	58.5
1884	634,887	634,887	38,880,000	60.264	61.2
1885	673,050	673,050	43,379,000	67.237	64.5
1886	750,000	728,929	45,304,000	70.221	62.2
1887	765,000	741,104	46,278,000	71.731	62.4
1888	782,221	756,195	49,794,000	77.181	65.8
1889	852,467	823,367	52,197,000	80.905	63.4
1890	853,945	853,587	55,201,000	85.562	67.0
1891	880,780	846,330	58,083,000	90.029	68.6
1892	957,958	919,417	67,566,000	104.727	73.5
1893	1,003,781	961,039	75,823,000	117.526	78.9
1894	1,080,000	996,500	71,360,000	110.608	71.6
1895	1,105,000	1,013,500	75,735,000	117.389	74.7

GAGINGS OF LONG ISLAND STREAMS.

The principal results of gagings made prior to the year 1903 are shown in the accompanying tables.[a]

The following gagings, by William McAlpine, were made by inserting in the streams wooden sluiceways, through which all the surface flow was passed. The drainage basin of Parsonage Creek is given as 21.74 square miles, and the combined areas tributary to all the streams which extended along the south shore from Jamaica Creek to East Meadow Brook is stated to be somewhat in excess of 100 square miles.

The precipitation at Erasmus Hall during the period of gaging was as follows:

Precipitation at Erasmus Hall, Long Island.

Month.	Precipitation.	
	1851.	Normal.
	Inches.	*Inches.*
July	3.85	3.21
August	3.23	4.44
September	1.06	3.09
October	4.47	3.39
November	3.99	3.24
December	2.01	3.74
Period	18.61	21.11

Gagings of Long Island streams by Wm. J. McAlpine and L. S. Nash in 1851.

Body of water.	Duration of gaging.	McAlpine and Stoddard, Oct. 11, 1851.		Duration of gaging.	Mean of L. S. Nash's gagings Nov. 6, 7, 8, 1851.		Duration of gaging.	Mean of L. S. Nash's gagings, Nov. 17, 18, 19, 1851.	
	Hours.	*Gallons per day.*	*Second-feet.*	*Hours.*	*Gallons per day.*	*Second-feet.*	*Hours.*	*Gallons per day.*	*Second-feet.*
Baisley's Pond (Jamaica Creek)	6	5,280,000	8.18	12	6,233,172	9.67	7½	8,440,312	13.08
Springfield Stream (Nostrand's Pond), West Branch	8	1,600,000	2.48	11	1,689,160	2.62	8	1,890,864	2.93
Springfield Stream, East Branch	24	264,000	.41	24	300,072	.46	24	354,384	.55
Hook Creek, West Branch (or Brookfield Stream)	13	4,095,000	6.34	12	4,339,720	6.73	14	4,989,782	7.73
Hook Creek, Middle Branch (or Clear Stream)	24	540,000	.84	24	771,816	1.20	24	969,600	1.50
Hook Creek, East Branch (Valley Stream)	6	2,430,000	3.77	6	2,510,643	3.88	6	3,374,742	5.22
Pine Creek (Pine's Brook)	6	2,400,000	3.72	6	2,832,240	4.39	6½	3,249,423	5.04
Parsonage Creek	7	8,330,000	12.91	12	10,543,464	16.28	12	12,594,348	19.53
Millburn, West Branch	.....	.....	.....	24	473,328	.73	24	518,400	.80
Millburn, Middle Branch	6	504,000	.78	24	299,616	.46	24	375,840	.58
Millburn, East Branch	.....	.....	.....	24	2,836,152	4.40	24	4,276,800	6.63
East Meadow Stream	10	5,340,000	8.28	12	5,601,756	8.68	12	6,280,800	9.73

[a] Chiefly from "Brooklyn Water Supply," De Varona, 1896, Table No. XVI.

Mean monthly discharge of Long Island streams from gagings made by Artemus Whitlock in 1852.

Body of water.	August.		September.		October.		November.		December.	
	Gallons per day.	*Second-feet.*	*Gallons per day.*	*Second-feet.*	*Gallons per day.*	*Second-feet.*	*Gallons per day.*	*Second-feet.*	*Gallons per day.*	*Second-feet.*
Baisley's Pond (Jamaica Creek)	6,387,000	9.90	6,863,000	10.65	6,154,000	9.53	7,804,000	12.09	8,137,000	12.62
On West Branch Hook Creek, or Brookfield Stream:										
Simonson's Pond							2,701,000	4.18		
Conselyea's Pond	2,847,000	4.42	4,793,000	7.42	2,493,000	3.85	3,121,000	4.84	4,769,000	7.39
Valley Stream (P. Cornell's)							4,616,000	7.16		
On East Branch Hook Creek	3,078,000	4.74	5,445,000	8.43	3,319,000	5.15	3,601,000	5.58	5,257,000	8.15
Pine's Brook	2,714,000	4.20	3,447,000	5.35	2,464,000	3.81	3,121,000	4.84		
On Parsonage Creek:										
Hempstead Pond			[a]16,682,000	26.20						
Hempstead storage reservoir			10,228,000	15.81	8,993,000	13.93	12,003,000	18.60		

[a] The increase of flow was caused by heavy rains just before taking the observations.

Miscellaneous gagings of Long Island streams.

Body of water.	Gagings made by Leigh, Stoddard, and Brevoort, completed Sept. 9, 1854.		Gagings made under direction of Jas. P. Kirkwood, 1856–57.		Gagings made Sept. 19 to Oct. 12, 1885.		Estimate of the minimum flow based on gagings made Aug. 30 to Oct. 5, 1894.	
	Gallons per day.	*Second-feet.*	*Gallons per day.*	*Second-feet.*	*Gallons per day.*	*Second-feet.*	*Gallons per day.*	*Second-feet.*
Baiseley's Pond (Jamaica Creek)	6,732,000	10.43	2,924,000	4.53				
Springfield Stream, West Branch	3,487,000	5.41	607,000	.94				
Springfield Stream, East Branch								
Hook Creek, West Branch (Simonson's Pond), or Brookfield Stream	2,501,000	3.88	1,798,000	2.79	1,266,000	1.97	2,000,000	3.10
Hook Creek, Middle Branch, or Clear Stream			708,000	1.10			200,000	.31
Hook Creek, East Branch, or Valley Stream	4,212,000	6.53	2,287,000	3.55	1,879,000	2.91	1,300,000	2.01
Watt's Pond, on East Branch Hook Creek, below Valley Stream Pond								
Pine's Brook			2,460,000	3.81	1,050,000	1.63	600,000	.93
Schodack Brook					695,000	1.08	1,000,000	1.55
Hempstead Pond (L. Cornell's)	11,266,000	17.51	7,326,000	11.36				
Hempstead storage reservoir					7,149,000	11.08	8,000,000	12.40

In thirty days preceding the gagings of October 11, 1851, 1.62 inches of rain fell, an additional precipitation of 3.85 inches preceded the second series of gagings, and a further increase of 0.92 inch of rainfall occurred before the third series of gagings were made.[a]

Details as to the methods of gaging, precise location, and drainage areas above the points of gaging, or daily discharge results, are unavailable.

It is known, however, that, beginning with McAlpine's gagings in 1851, most of the measurements have been made in flumes or sluiceways constructed for the purpose, the velocity and area of cross section being determined without

[a] Report made to the water committee of the common council, city of Brooklyn, 1852, p. 117.

disturbing the ground-water conditions or affecting the relative ground-water level above and below.

Most of the streams flow in flat swamp valleys underlain by gravel so porous that the flow from a large spring that was observed was absorbed or lost in the soil within a short distance from its origin. The velocity of flow of ground water adjacent to an earthen dam has been observed by Professor Slichter[a] to be many times greater than the normal velocity in places where the ground-water level is undisturbed.

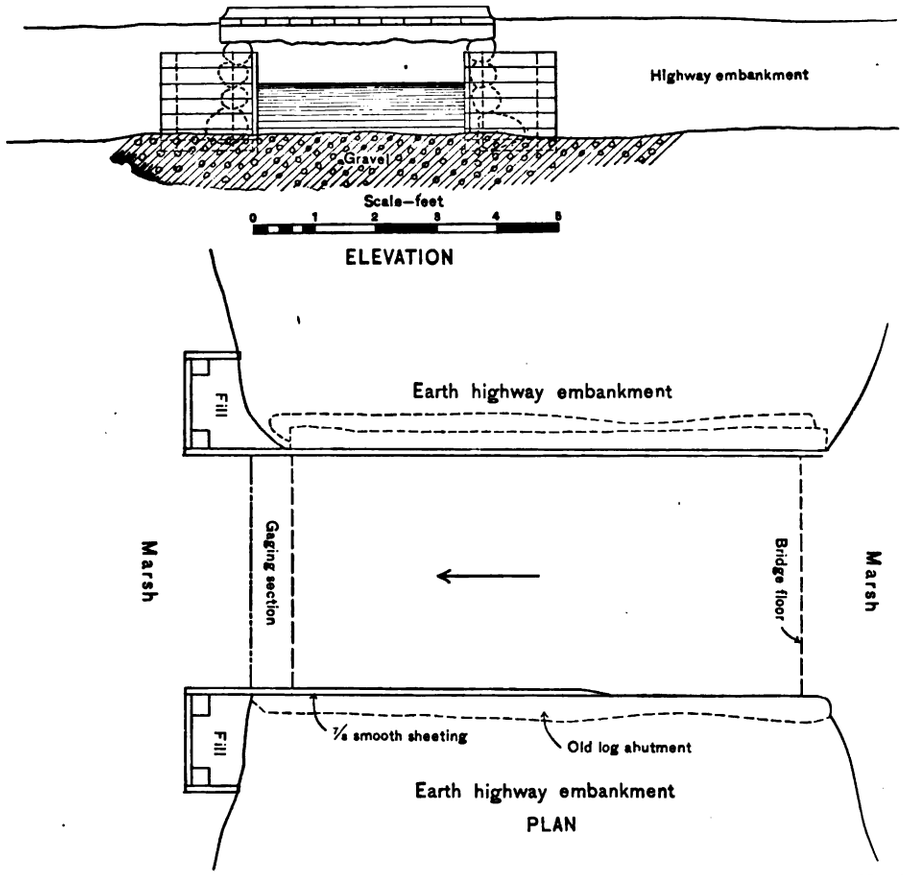

FIG. 70.—Temporary gaging station of the United States Geological Survey, Orowoc Creek, Islip, Long Island, New York, June 7, 1903. Plan shows bridge floor removed.

Care must be exercised in gaging such streams to properly differentiate between the surface discharge of the streams and the underflow in the porous valleys. The method of gaging in open sluiceways, generally used by the earlier engineers, was followed in the investigations of the United States Geological Survey in 1903, except on Orowoc Creek, Doxsee Creek, and Massapequa Creek, streams on which suitable sites for gaging at moderate expense could be found only in conjunction with existing weirs at private ponds.

[a] See pp. 106–110.

The gagings of the United States Geological Survey in 1903 included most of the remarkable period of light rainfall in May and June. They were discontinued early in July, after heavy rains had fallen, disturbing the ground-water conditions.

In the following pages are also given results obtained at a number of elaborate small weirs erected by the New York water supply commission, chiefly in the swamp stream valleys on the property of the city of New York, in Nassau County.

Most of the current-meter measurements of the Geological Survey were made with a specially rated Fteley meter. Vertical velocity curves were taken to determine the distribution of currents in the stream channel. The steady regimen and smooth currents of many of the streams favor accurate results by this method. Some of the stations were not fully completed and none of the rating curves were finished at the time of discontinuance. Points were obtained on the curves in most cases to cover nearly the full range of observed gage heights and to afford a reliable basis of estimating the discharge. The streams gaged were distributed along the south shore of the island, and the individual cost of gagings was a small fraction of that required to build individual weirs.

In conjunction with the surface-stream and driven-well supply stations of the Brooklyn waterworks, records have been kept of the ground-water level, showing its reduction by pumping in a most interesting manner.[a] Records of the pumpage and diversion and of the supply pond levels have also been kept. The waste over the spillways when observed in 1903 was largely in the nature of wave wash and not susceptible of accurate estimation. Unfortunately, these records do not furnish a reliable basis for estimating the yield of the streams flowing into the water-supply ponds. The regimen of these streams is further subject to the influence of pumping from the adjacent ground water.

Prior to the gagings of 1903 very few definite data were obtained concerning the regimen of the surface streams of Long Island. The results for 1903 do not of themselves form a sufficient basis for estimating either the average or the minimum yield of the Long Island catchment areas.

EAST MEADOW BROOK, NEAR FREEPORT, LONG ISLAND.

East Meadow Brook has its visible source 5 miles from the south shore of Long Island. Well-defined stream channels, somewhat branching, extend nearly to the northern limit of the catchment basin, receiving the surface drainage from its east and west portions.

The drainage basin extends inland 14 miles and has a nearly uniform width, varying from 2 to 3 miles. The topography is moderately rolling and the surface slope quite uniform, the northerly divide being about 300 feet elevation above tide.

Five ponds and dams are on the main stream. Small water powers for grist mills and a paper mill were formerly in use.

The stream is tributary to the Brooklyn water supply through an intercepting conduit, which follows the south shore of the island.

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[a] See De Varona, Brooklyn Water Supply.

A portion of the drainage basin lies north of the ground-water divide of Long Island. The catchment basin contains 28 per cent of forest cover, chiefly scrub oaks and conifers, 44 per cent pasture and other grass land, and about 28 per cent of cultivated land.

Earlier gagings of East Meadow Brook at Freeport, Long Island.

Date.	Observer.	Gallons per day.	Second-feet.	Second-feet per square mile (31 square miles).
October 11, 1851	McAlpine and Stoddard	6,410,000	9.93	0.32
November 6, 7, 8, 1851	L. S. Nash	6,724,000	10.42	.33
November 17, 18, 19, 1851	do	7,539,000	11.69	.38
August, 1852	Artemus Whitlock			
September, 1852	do	[a] 16,270,000	25.26	.81
		9,583,000	14.85	.48
October, 1852	do	7,324,000	11.35	.37
November, 1852	do	7,324,000	11.35	.37
December, 1852	do			
June 1 to October 15, 1883[b]		5,200,000	8.06	.26
September 19 to October 2, 1885.		4,217,000	6.54	.21

[a] This increase in flow caused by heavy rains just before observations were taken.
[b] For conduit east of Rockville Center.

Mean daily discharge, in second feet, of East Meadow Brook near Freeport, Long Island, for 1903.[a]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	[b]28.42		18.04	24.38	14.41	15.49	13.56	18			20.22	24.05	15.36	16.81	32.22
2			18.13	21.82	13.38	16.07	12.71	19			22.97	29.07	14.12	16.07	22.45
3			17.89	24.30	15.43	16.02	13.72	20			23.84	20.36	15.28	14.72	16.00
4			17.48	23.14	14.94	15.20	16.30	21			25.98	20.29	16.09	13.35	16.49
5			17.48	22.00	63.95	16.88	14.30	22	[b]40.73		24.28	18.79	15.41	13.44	16.23
6			18.15	21.41	23.87	17.27	13.07	23			24.31	23.68	14.89	13.02	16.12
7			24.95	20.80	29.32	15.56	12.77	24			28.37	17.26	18.36	13.21	15.80
8			31.59	19.16	18.50	13.32	13.68	25			25.21	17.66	14.18	13.09	15.90
9			26.92	17.50	18.79	14.02	35.93	26			21.96	16.08	15.65	13.25	16.09
10			19.35	19.20	16.09	13.72	29.70	27			21.37	16.20	17.21	13.76	15.71
11			19.87	18.86	18.70	13.49	14.91	28			20.56	15.58	22.69	16.17	15.59
12			41.89	19.97	19.73	13.32	19.93	29			28.85	15.62	32.55	13.41	15.80
13			40.37	24.20	17.19	13.45	15.30	30			36.92	16.38	25.99	13.84	15.68
14			22.59	21.20	16.72	14.38	14.49	31				16.08	17.65		15.88
15			38.42	18.31	15.58	15.06	13.88	Mean			25.17	20.02	20.36	14.78	17.11
16			32.24	17.95	15.55	19.85	12.90								
17			24.82	19.32	16.79	15.12	21.30								

[a] Weir of New York water supply commission in swamp at head of Brooklyn waterworks supply pond.
[b] Current meter measurement by U. S. Geological Survey.

NEWBRIDGE STREAMS NEAR MERRICK, LONG ISLAND.

These streams drain the first catchment area lying east of East Meadow Brook. The surface drainage is 3.3 square miles. The larger tributary has its visible source 2 miles from tide water.

The stream valley extends inland nearly to the head of the catchment basin. This catchment basin has a maximum width of 1 mile near the foot, decreasing in width toward the northern end. The topography is flat and the surface slope is quite uniform, the head of the basin being at altitude 100 feet above tide. About 58 per cent of the catchment area of these streams has forest cover, 19 per cent is sodded, and about 22 per cent is under cultivation. The Newbridge streams are tributary to the Brooklyn waterworks.

Mean daily discharge, in second feet, of Newbridge streams near Freeport, Long Island, for 1903.[a]

Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.
1	4.07	3.76	2.65	12	4.91	3.10	3.00	23	3.33	2.83	3.42
2	4.02	3.59	2.55	13	4.37	3.16	3.00	24	3.44	2.78	3.36
3	3.92	3.54	2.79	14	4.22	3.03	2.99	25	3.34	2.73	3.37
4	4.66	3.47	2.47	15	4.30	3.00	2.94	26	3.57	2.74	3.43
5	12.40	3.69	2.57	16	4.23	4.42	2.90	27	3.26	2.69	3.36
6	6.34	3.18	2.66	17	4.11	3.45	4.01	28	4.41	2.99	3.43
7	5.65	3.26	2.55	18	3.78	3.39	4.63	29	4.05	2.72	3.43
8	4.94	3.27	2.55	19	3.61	3.01	3.75	30	4.63	2.84	3.38
9	4.81	3.27	5.25	20	3.71	2.94	3.61	31	4.02	.....	3.37
10	4.73	3.28	3.66	21	3.42	2.93	3.51	Mean...	4.47	3.15	3.27
11	5.29	3.23	3.33	22	3.38	2.87	3.47				

[a] At weirs of New York water supply commission.

WANTAGH STREAMS AT WANTAGH, LONG ISLAND.

A group of short branching streams, having their visible sources 3 miles inland, drain a relatively flat area, the topographic boundary of which is difficult of precise determination, but has been estimated at 17.6 square miles. This area lies entirely south of the ground-water divide of Long Island. The drainage area is lenticular, the northern end lying at elevation 250 feet. A dry stream valley, not very clearly demarcated, extends nearly to the northern limit of the basin.

The drainage basin contains about 40 per cent cultivated land and an equal percentage of pasture and grass areas, the remainder being chiefly wooded. There are several private ponds near the mouth of the stream. Water has also been diverted to the conduit of the Brooklyn waterworks since 1891.[a]

The stream above Seamans Pond is divided between three channels. Two low weirs were erected just above Seamans Pond, and gaging records were maintained there from July 21 to November 8, 1903, by the New York water supply commission.

The discharge determined from gagings June 1 to October 15, 1883, is stated at 3,400,000 gallons (5.25 second-feet). The year 1883 was preceded by several years of somewhat deficient rainfall. Details of these gagings are not available.

Mean daily discharge, in second-feet, of Wantagh streams at Wantagh, Long Island, for 1903.[a]

Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.
1		11.63	14.05	11.20	12		16.73	12.52	14.02	23	16.62	12.24	12.19	12.80
2		12.21	11.84	10.52	13		13.18	11.33	12.51	24	13.12	11.93	10.18	12.12
3		12.07	12.92	11.51	14		14.89	9.93	10.11	25	12.75	10.73	11.03	12.13
4		13.10	14.91	9.85	15		13.62	11.90	12.60	26	8.53	13.86	10.52	11.40
5		48.30	14.67	13.07	16		13.66	14.22	11.30	27	9.82	12.56	11.27	12.30
6		21.19	14.11	9.81	17		14.19	13.76	19.28	28	11.36	18.70	12.68	12.67
7		17.31	12.61	10.31	18		10.88	13.09	19.90	29	12.52	25.65	10.06	12.67
8		16.00	10.85	10.23	19		13.35	10.71	14.06	30	12.19	19.92	13.75	12.56
9		15.67	13.21	29.81	20		13.72	12.75	12.86	31	12.30	10.07		12.06
10		16.23	12.79	14.99	21	13.55	12.26	9.68	11.17	Mean	15.68	12.17		13.13
11		18.46	10.78	13.59	22	14.35	12.36	11.10	13.12					

[a] At weirs of New York water supply commission.

MASSAPEQUA CREEK AT FARMINGDALE AND FREEPORT, LONG ISLAND.

Massapequa Creek drains an area extending inland a distance of 14 miles from the mouth of the stream. In shape, the drainage basin is irregular, but gradually increases from a width of 1 mile at the mouth to a maximum width of 5 miles near the northern divide. The topography is diversified, including a flat valley on the east; a table-land on the north, comprising about 5 square miles, the drainage from which is chiefly into depressions; a group of hills rising to altitude 300 feet near the center of the basin; and a generally southerly slope, somewhat rolling, in the southwest portion of the surface catchment area.

The stream comprises three short branches which unite 2 miles above the outlet of the stream into tide water. The longest branch has its visible source at a distance of 5 miles inland. A gaging station was established on this branch of the stream May 6, 1903, at a small weir forming the outlet of a private pond. The area of the pond is so small as to exert but little regulating influence, and the stream entering the pond is entirely unregulated.

In order to procure a record at as early a date as possible readings were taken on the weir without modification, until such changes could be made as were desirable to secure the best results during low water. The weir was located just above the head of the property of the Brooklyn water department.

The stream below the weir flows through a marsh valley, bordered by sandy slopes. The bed of the marsh is porous gravel overlain by 2 or 3 feet of muck and vegetation, through which the surface waters percolate.

Springs enter the margin of the small pond at the Farmingdale weir, and the stream has its visible sources a short distance above this pond. The precise point at which the stream rises apparently varies with the season and stage of ground water, which also determine the position of the seepage or wet sand areas observed on the slopes in certain places in this catchment basin. Throughout the lower portion of the drainage basin the ground-water horizon lies within a few feet of the surface. The entire drainage basin lies south of the summit of the ground-water table of Long Island.

[a] See The Water Supply of the City of Brooklyn, by I. M. De Varona, 1896, page 74.

Massapequa Creek is utilized in conjunction with the water-supply system of Brooklyn. The drainage basin and the position of the conduit line are shown on the Northport and Babylon sheets of the United States Geological Survey's topographic map. The drainage areas are as follows:

Drainage areas, Massapequa Creek.

	Square miles.
Farmingdale gaging station	13.7
Above gaging station, Brooklyn waterworks	40.0
Above outlet Brooklyn waterworks supply pond	40.9
Above mouth of stream, at tide water[a]	41.5

The catchment area comprises about 60 per cent woodland, 20 per cent sodded areas, and 20 per cent of land under cultivation.

A series of gagings of this stream, June 1 to October 15, 1883, at a point near the mouth showed a mean discharge of 3,097,000 gallons, or 4.8 second-feet. Details are not available.

Mean daily discharge, in second-feet, of Massapequa Creek at Farmingdale, Long Island, for 1903.

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1	.....	0.94	0.49	0.43	0.43	18	1.28	0.72	.....	0.39	0.25
2	.....	.94	.49	.43	.35	19	1.28	.72	.....	.35	.17
3	.....	.86	.49	.43	.32	20	1.28	99	.....	.43	.18
4	.....	.79	49	28	.32	21	1.28	.99	.....	.35	.17
5	.....	.....	49	1.68	.30	22	1.28	.72	.....	.31	.17
6	2.06	.72	.49	.89	.25	23	1.28	.72	.....	.35	.11
7	2.06	1.56	.49	.81	.21	24	1.28	.59	.....	.31	.12
8	2.06	1.11	.49	.63	.18	25	1.28	.49	.....	.43	.11
9	2.06	.72	.49	.62	.20	26	1.28	.38	.....	.42	.21
10	2.06	.72	.49	.53	.22	27	1.28	.30	.....	.33	.15
11	2.06	.72	.87	.62	.22	28	1.28	.30	.....	.88	.19
12	2.06	1.89	.72	.52	.17	29	1.11	1.89	.....	1.06	.07
13	2.06	1.11	.72	.47	.14	30	.94	.84	.46	.62	.10
14	2.06	1.26	.61	.46	.18	31	.94	.....	(b)	.50	(c)
15	1.66	.99	.49	.43	.16	Mean	.....	.....	.....	.49	.20
16	1.28	.72	.49	.43	.32						
17	1.28	.72	.....	.42	.31						

[a] The Brooklyn waterworks supply from this stream is described in The Water Supply of Brooklyn, by I. M. De Varona, 1896, pp. 75–76.

[b] Gage readings by New York water-supply commission beginning July 31, 1903.

[c] Stream reported to go dry at times.

Mean daily discharge, in second-feet, of Massapequa Creek at Massapequa, Long Island, for 1903.[a]

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1		20.51	10.77	13.59	8.92	18		12.18	10.62	12.31	16.12
2		18.07	10.27	12.08	8.75	19		15.53	10.32	10.32	13.50
3		17.55	9.61	11.25	9.21	20	17.33	14.57	10.85	9.71	11.47
4		16.88	10.47	11.10	8.90	21	20.13	16.07	10.42	9.24	11.09
5		16.16	29.50	11.65	8.71	22	15.65	14.40	9.87	9.18	10.62
6		16.37	24.54	11.47	8.70	23	18.70	13.99	9.82	9.14	10.50
7		16.06	20.76	10.69	8.64	24	23.51	13.03	9.91	9.06	10.35
8		15.16	15.69	10.37	8.50	25	18.54	12.97	10.69	8.86	10.25
9		14.83	14.39	10.34	19.72	26	17.16	12.42	12.02	8.65	10.17
10		14.28	13.70	10.33	18.98	27	16.39	11.23	10.82	9.12	9.98
11		15.39	14.63	10.13	13.86	28	15.75	11.05	16.28	11.30	9.98
12		14.86	14.91	9.81	12.23	29	21.18	10.81	26.54	9.36	9.82
13		16.01	11.59	9.60	10.99	30	28.58	10.99	21.62	8.89	9.76
14		15.29	12.21	9.51	10.24	31		10.99	15.74		9.76
15		13.98	11.70	9.42	9.71	Mean		14.47	13.96	10.29	11.02
16		13.62	11.29	10.70	9.53						
17		13.11	11.10	11.26	12.72						

[a] At weir of New York water-supply commission.

CARLLS RIVER AT BABYLON, LONG ISLAND.

The drainage basin of this group of streams extends northward to within 2 miles of tide water, where it drains a small flat area at elevation 200 feet. A surface drainage valley can be traced from the head of the area following closely the right-hand watershed line to the head of the surface stream near Wyandanch.

The central portion of the drainage basin is 5 miles wide and includes the Half Hollow and Dix group of hills. The Colonial Springs issue from the south slope of Half Hollow Hills. The outflowing streams are absorbed by the soil, after running for a short distance.

The surface stream is branching and its valley is flat and marshy. Its longest branch is visible about 5 miles above the mouth. Five large private ponds have been constructed on the main branches, and the regimen of flow is largely arbitrary.

The drainage basin is shown on the Northport and Babylon sheets of the United States Geological Survey's topographic map, and covers 365 square miles above the gaging stations.

Highway embankments across the swamp valley serve to concentrate the flow of surface waters into narrow bridge openings, but some water may be lost by diversion into the surrounding gravels, due to the ponding. Temporary gages were erected at bridges crossing the two main branches of the stream above Kennel Club Pond, May 6, 1903. The gaging stations were completed early in June by planking the side walls of the bridges, affording smooth rectangular channels in which current-meter measurements were made. The combined discharge at the two gaging stations represents the total surface flow of the stream, and is shown in the following table.

List of discharge measurements of Carlls River (East and West branches) at Babylon, Long Island, for 1903.

WEST BRANCH.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
May 6	E. P. Roundy	1.50	9.60
June 13	E. P. Roundy and A. P. Porter	1.735	15.96
July 6	A. P. Porter	1.66	12.73

EAST BRANCH.

May 6	E. P. Roundy	1.10	26.58
June 13	E. P. Roundy and A. P. Porter	1.395	37.13
July 6	A. P. Porter	1.185	28.37

BOTH BRANCHES.

May 6			36.18
June 13			53.09
July 6			41.10

Combined mean daily discharge, in second-feet, of East and West branches of Carlls River, at Babylon, Long Island, for 1903.

Day.	May.	June.	July.	Day.	May.	June.	July.	Day.	May.	June.	July.
1	.....	34.9	42.5	12	(a)	60.2	35.5	22	41.4	36.5	.....
2	.....	34.4	(a)	13	(a)	54.4	42.2	23	37.1	41.4	.....
3	.....	34.4	59.6	14	(a)	43.3	47.9	24	35.6	47.5	.....
4	.....	33.7	36.6	15	32.1	37.8	45.8	25	35.6	46.0	.....
5	.....	34.0	37.2	16	32.1	33.7	42.5	26	36.6	43.2	.....
6	35.6	34.5	40.5	17	32.1	40.5	42.4	27	37.7	38.0	.....
7	35.6	44.8	43.2	18	32.1	48.2	.....	28	42.4	35.9	.....
8	35.6	60.5	40.9	19	32.1	58.2	.....	29	39.4	44.9	.....
9	35.6	46.3	37.6	20	34.5	55.6	.....	30	37.7	.....	.....
10	35.6	46.9	39.1	21	53.2	40.8	.....	31	35.6	.....	.....
11	32.1	42.5	56.9								

a Record not available.

The current-meter rating curves were never completed, but the measurements were made with great care and covered nearly the full range of fluctuation of the streams during the period of gaging. They are sufficient to afford a reliable estimate of the flow during the remarkable drought of May-June, 1903.

A small portion of the surface area of this stream lies north of the groundwater divide.

SAMPAWAMS CREEK.

The surface drainage area of this stream extends inland 14 miles. The basin is narrow and elongated, the average width for 9 miles from the coast being 1 mile. The northern end of the basin broadens out, and includes the Commack plateau, which lies at elevation 180 to 200 feet above tide. The visible stream rises within 5 miles of the coast, but a well-defined stream valley extends much farther inland and may be traced on the topography quite to the northern divide.

The stream flows through a broad, flat valley, having a firm gravel soil overlain with muck, bog, and swamp vegetation. The Long Island Railroad embankment at Babylon forms an effectual cut-off for the flow of surface water through the swamp, and at the same time does not materially change the surface level or modify the ground-water conditions. The gaging station was selected at the point where the surface waters of the swamp valley are concentrated at the opening under this embankment.

In order to secure results as early in the season as possible, a gage was erected and measurements were begun early in May, 1903. In June a temporary measuring flume was constructed just above the railroad embankment. Meter measurements were made with a specially rated Fteley meter in every square foot of the cross section or oftener where necessary, in order to determine local current irregularities, and vertical velocity curves were determined at 0.1-foot intervals from surface to bottom. The data of two of these velocity curves, showing the current in a shallow stream flowing over a smooth hard gravel bed, are given below:

Data from vertical velocity curves, Sampawams Creek, Babylon, Long Island.

[Measurements by A. P. Porter. Meter, Fteley No. 107.]

Data.	June 26, 1903.	June 30, 1903.	Mean of two.
Station	15	8	
Gage.....feet	0.58	0.74	0.61
Depth.....do	.92	1.02	.97
Mean velocity	.923	1.125	1.024
Surface velocity	.89	1.189	1.04
Per cent of mean	.964	1.048	1.006
Bottom velocity	.80	.88	.84
Per cent of mean	.866	.782	.824
Maximum velocity	.965	1.191	1.078
Per cent of mean	1.045	1.058	1.051
Depth of maximum.....feet	.30	.15	.225
Per cent of depth	.326	.147	.236
Depth of point of mean velocity...feet	.62	.61	.615
Per cent of total depth	.674	.60	.637

Mean daily discharge, in second-feet, of Sampawams Creek at Babylon, Long Island, for 1903.

Day.	May.	June.	July.	Day.	May.	June.	July.	Day.	May.	June.	July.
1	.....	12.3	23.5	12	13.4	(a)	15.0	22	12.9	13.4	.....
2	.....	12.0	15.4	13	15.4	15.0	15.4	23	13.2	15.0	.....
3	.....	12.2	13.4	14	15.4	17.1	14.6	24	13.4	14.4	.....
4	.....	12.2	12.6	15	15.4	15.0	13.8	25	12.9	13.2	.....
5	.....	12.3	12.4	16	15.4	13.6	.....	26	12.3	13.6	.....
6	21.4	12.4	12.4	17	13.2	13.2	.....	27	12.6	13.6	.....
7	16.8	(a)	12.4	18	13.2	13.2	.....	28	13.4	13.0	.....
8	15.4	20.9	12.5	19	12.6	14.4	.....	29	13.4	20.1	.....
9	15.4	18.8	13.1	20	14.4	17.8	.....	30	12.2	(a)	.....
10	14.2	13.8	13.2	21	13.2	13.1	.....	31	15.0	.....	.....
11	12.8	13.8	13.4								

a Above rating table.

The drainage basin of Sampawams Creek is shown on the Northport and Babylon sheets of the United States Geological Survey's topographic map. The surface drainage area above the gaging station is 23 square miles, and above the mouth of the stream 24 square miles.

The ground-water divide crosses the basin near the foot of the upper broad area. The surface drainage area below the ground-water divide is about 10 square miles. Water power is developed at tide water; an earth dam affords 6 feet head to a whip factory and sawmill. There are also several small private ponds on the stream. At one of these, at the Unkeway Nurseries, a small turbine is in use under 5 feet head.

OROWOC AND DOXSEE CREEKS, ISLIP.

These streams drain a long, narrow area extending 6 miles inland and comprising topographic areas as follows:

	Square miles.
Orowoc Creek	7.24
Doxsee Creek	1.25
Total	8.49

The ground-water divide at the north of the drainage areas of these streams probably lies some distance north of the surface divide. Both streams flow through swampy valleys crossed by fairly impermeable dikes constructed for highways. A temporary gaging station was maintained on Orowoc Creek, May 9 to July 16, 1903, inclusive. The gage, a finely divided scale, was erected at the first highway bridge above the Long Island Railroad in Islip.

The stream passes through a single rectangular span 4 feet in width, having timber sides and smooth gravel bottom. The section was rendered suitable for accurate gaging by moderate repair, and the following measurements were made with a specially rated current meter, velocities being taken in every square foot of cross-sectional area or less:

Discharge measurements of Orowoc Creek for 1903.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
May 9[a]	E. P. Roundey	1.45	8.86
June 13	A. P. Porter	1.47	9.00
July 7	do	1.38	5.93

[a] Gaging station not completed.

Orowoc Creek is utilized as a supply for a small private pond at the South Shore Highway. A second small pond lies above the gaging station. The stream above the point of gaging is practically uncontrolled.

Doxsee Creek was gaged at a weir forming the outlet of a private pond. The regimen of the stream was arbitrarily controlled at times as required for flooding of cranberry flats.

In order to secure a record as early as possible in the season, a gage was erected at the existing weir May 6, 1903. A metal crest weir conforming essentially to fixed standards was installed June 6, 1903, and the record continued until July 15, 1903.

Combined mean daily discharge, in second-feet, of Orowoc and Doxsee creeks at Islip, Long Island, for 1903.

Day.	May.	June.	July.	Day.	May.	June.	July.	Day.	May.	June.	July.
1			11.82	12	27.06	17.30	7.14	22	[b]6.77		
2			11.80	13	26.67	10.52	8.67	23			
3			11.15	14	26.67	14.74	7.57	24			
4			11.15	15	26.67	10.84	6.99	25		11.42	
5			11.06	16	26.60	10.11	7.14	26		10.72	
6			10.97	17	25.35			27		10.20	
7		13.91	10.57	18	24.61			28		10.05	
8		14.36	9.07	19	21.87			29		12.96	
9	[a]29.70	10.11	7.98	20	18.17			30		12.42	
10	30.99	3.31	7.57	21	12.83			31			
11	27.19	3.13	7.64								

[a] May 7 to 21, inclusive, drawing water from pond above gage on Doxsee Creek.
[b] May 22 to June 6, inclusive, refilling pond above gage on Doxsee Creek.

The drainage areas of these streams are shown on the Setauket and Fire Island sheets of the United States Geological Survey's map.

Champlin Creek, lying immediately east of Islip, drains a surface area of 6.9 square miles above the South Shore highway. The drainage basin is long and narrow and the surface stream extends well inland, the lower course being turned into private ponds.

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CONNETQUOT BROOK, NEAR GREAT RIVER, LONG ISLAND.

The catchment area of several small streams entering Connetquot Bay comprises an irregular rectangle 2 miles wide at tide water, extending inland 7 miles, and 6 miles wide at the northern divide. The topographic area is 19.6 square miles above tide limit at the South Shore highway. Of this area, 5.6 square miles is tributary to Cutting Creek, on which a separate gaging station was temporarily maintained in 1903. The remainder is tributary to the Connetquot streams.

Ponds have been constructed for pleasure parks above the South Shore highway, and these ponds control the outflow of the several branches. The central branch heads near the northern watershed divide. The discharge of this branch was determined as follows, at the South Shore highway crossing:

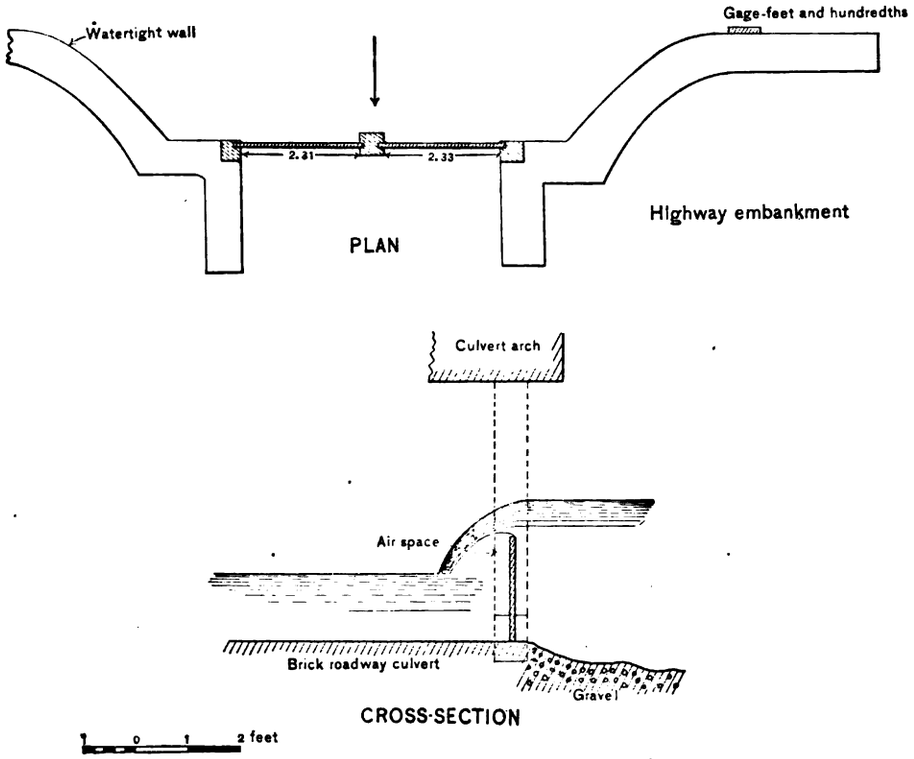

FIG. 71.—Weir on private pond, Cutting Creek, near Great River, Long Island.

Discharge measurements of central branch of Connetquot Brook, for 1903.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
Apr. 22....	R. E. Horton.....	.....	69.5
June 20...	E. P. Roundey.....	2.57	58.3
July 1.....	A. P. Porter.....	2.72	82.3

The results of gagings of Cutting Creek are given in the following table. The regimen is rendered artifical by pondage.

The discharge was obtained at an existing pond weir having a level crest, free discharge, four complete contractions, and no velocity of approach. The discharge usually varied but little during a single day, and the mean of two readings on a finely divided scale has been used in conjunction with the Francis formula in calculating the discharge.

Mean daily discharge in second-feet of Cutting Creek at East Islip, Long Island, for 1903.

Day.	May.	June.	July.	Day.	May.	June.	July.	Day.	May.	June.	July.
1		(a)	6.19	12	4.12	13.60		23	0.64	6 22	
2		(a)	6.19	13	4.12	6.78		24	.32	6.40	
3		(a)	6.01	14	3.41	13.60		25	.64	6.19	
4		(a)	6.22	15	2.17	14.17		26	.32	6.40	
5		(a)	6.01	16	2.17	12.64		27	.64	6.01	
6		(a)		17	.32	9.52		28	.64	6.01	
7		(a)		18	.32	5.19		29	.46	6.19	
8		5.58		19		5.33		30	.64	6.22	
9		7.20		20		5.58		31			
10	5.58	8.04		21	.37	5.54					
11	5.58	9.83		22		6.01					

a Water reserved as pondage, June 1 to 7, inclusive.

LAKE RONKONKOMA AND ADJACENT STREAMS.

The inland basin of Lake Ronkonkoma lies immediately north of the topographical catchment area of the Connetquot streams. It appears probable that the ground-water divide lies considerably north of the surface divide between the catchment basins, so that the effective catchment tributary to the Connetquot streams is thereby increased.

Lake Ronkonkoma has a surface area of about 0.5 square mile, and receives the surface run-off from a total area of 8 square miles. This remarkable depression extends somewhat below sea level and represents virtually a natural well. The range of surface fluctuations of this lake has not been reliably determined.

Lake Ronkonkoma lies in a catchment basin topographically tributary to Nissequogue River, a northward-flowing stream having a surface drainage basin of 44 square miles. This is the largest basin on the north slope of Long Island. The surface stream extends inland nearly to the watershed line.

A brief reconnaissance of streams east of the Connetquot area was made April 23, 1903. Edwards and Tuttle creeks have surface drainage basins of 6.7 and 9 square miles, respectively, and are utilized at private ponds. Patchogue Creek, in addition to supplying private ponds, is utilized to furnish water power at the lace factory of the Patchogue Manufacturing Company, under a head of 14 feet. This stream drains a surface area of 14 square miles.

Swan River at East Patchogue affords a fall of about 12 feet at tide water, with good pondage. This stream drains a surface area of 7.8 square miles. The visible stream extends inland 4.5 miles. Its catchment area is narrow and elongated, extending 7 miles inland.

The South Shore highway dike is utilized as a dam on Mud Creek, affording a pond of perhaps 10 acres area, and about 6 feet fall, where a drag sawmill, with a breast water wheel, was formerly operated.

The estimated discharge of Mud Creek, April 23, 1903, was 6.7 second-feet, from a surface drainage area of 5 square miles.

CARMANS RIVER, OR CONNECTICUT RIVER OF LONG ISLAND.

The drainage area of this stream is an irregular triangle, having its apex at the mouth of the stream, and its base, which is about 10 miles in length, extending parallel to the north shore of Long Island, at an average distance of 1.5 miles therefrom, and at elevation 150 to 200 feet. The surface of the drainage basin slopes from elevation 150 near the northern divide to tide-water elevation at the mouth, in a distance of 12 to 13 miles. The surface stream extends inland only 10 miles. There are no perennial streams in the upper catchment area, although the topographic stream valley is defined nearly to the northern divide of the basin. The northwestern portion of the drainage basin lies in the Saint James plateau, north of the group of sand hills which lie near the center of the island at Selden, and reaches westward nearly to Lake Ronkonkoma.

The general topography is moderately rolling. A few undrained depressions of one-fourth square mile area or less are found near the northern divide, and the upper 2.5 miles of the course of a dry tributary valley on the left of the main stream have been cut off and form a depression.

The catchment area is overlain by sand and gravel, and is largely covered with scrub oaks and conifers.

From South Haven to the mouth of the stream, a distance of 3 miles, the channel is bordered by marsh and the current is sluggish. Tidal influence extends to South Haven.

A temporary gaging station was established at South Haven May 8, 1903, but was discontinued July 16, 1903, before an opportunity had been found to determine the range and cycle of daily tides at this point. The gage readings are not at present available. Discharge measurements were made as follows:

Discharge of Carmans River, Long Island, for 1903.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
April 23[a]			74
May 8	E. P. Roundey	1.86	[b]108
July 8	A. P. Porter	2.26	87.5

[a] Measured by floats. Gristmill not running. [b] Ebbing tide.

An earthen dike at South Haven affords a fall of 6 feet and a storage pond that is utilized by a gristmill and a sawmill.

An earthen dam at Yaphank affords extensive pondage. A custom saw and grist mill operate under a head of 10 feet.

One mile above Yaphank is a third dam, about 6 feet high, which has been abandoned.

The course of the stream intermediate to the dams is through a swamp channel. The major portion of the fall is utilized at existing dams.

The drainage basin is shown on the Moriches and Setauket sheets of the United States Geological Survey's topographic map.

Drainage areas of Carmans River, Long Island.

Location.	Place to place.	Total.
	Sq. miles.	*Sq. miles.*
Above upper bridge, Yaphank	69	69
Yaphank to South Haven	10	79
South Haven to mouth [a]	3.6	83

[a] Tidal section.

PECONIC RIVER.

This stream has the most extended surface-drainage basin on Long Island. Its drainage comprises an irregular rectangular area, of which the northern divide is within one-half mile to 1½ miles of Long Island Sound and at an altitude of 150 to 200 feet above tide. The general slope of the basin is toward the southeast. The surface divide on the west is not sharply defined, but is at an average elevation of 120 feet above tide.

The southern watershed is about 5 miles from the seacoast.

The drainage area above Calverton is in general flat and contains about 25 undrained depressions, chiefly of but a few acres area. Deep Pond, at an elevation of 23 feet, lies in the largest depression and receives the drainage from an area of 0.35 square mile.

Below Calverton the drainage on the north is comparatively flat and is besprinkled with undrained hollows.

Farther south the topography of the drainage basin is intricate and precipitous, the river valley being at an average elevation of 20 feet, and the southern divide, 2.5 miles distant, at elevations of 200 to 300 feet. Small undrained depressions are very numerous on this slope and receive a large proportion of the precipitation.

The drainage basin is shown on the Moriches and Riverhead sheets of the United States Geological Survey's topographic map, from which the following areas have been deduced:

Drainage areas of Peconic River, Long Island.

Location.	Place to place.	Total.
	Sq. miles.	*Sq. miles.*
Above Long Island R. R. bridge, near Calverton	59	59
Above Riverhead dam	25	84

Peconic River is tributary to Peconic Bay, which bifurcates the eastern end of Long Island. The surface stream is formed by the junction of two short branches 9 miles from Riverhead. At this point the stream is 40 feet above tide. Almost the entire fall from its source is taken up at flood dams for cranberry marshes and at water-power dams.

Water power on Peconic River.

Riverhead: Earth dike of usual Long Island type. Five to 7 feet head, varying with tide. Good pondage. Water privilege divided between the Tower mill and the Peconic gristmill.

Electric-light plant: One and one-half miles above Riverhead. Earth dike. Extensive pondage. Formerly a woolen mill, stated to have 95 horsepower, 6.5 feet head.

Dam No. 3: Forge and gristmill. Unused for many years. Earth dike; 5.5 feet fall.

Calverton: E. L. Brown gristmill. Five feet fall. Also unused drag sawmill. Antiquated "tub and flutter" water wheels.

A brief reconnaissance of this stream was made April 24, 1903. Slack water exists throughout almost the entire course of the stream, affording no opportunity for the erection of a weir. Sufficient fall exists at the Long Island Railroad bridge near Calverton to afford an opportunity for gaging. The discharge at this point was roughly estimated at 45 second-feet April 24, 1903, and as measured by E. P. Roundey May 11,1903, was 48 second-feet; gage height, 1.3 feet. April 24, 1903, the discharge at Manorville highway bridge, estimated from surface floats, was 33 second-feet. April 24, 1903, the discharge estimated from float measurements at the junction of the north and south branches 1.5 miles above Manorville was 22.5 second-feet.

The stream flows in a flat valley of the usual Long Island type. The channel is bordered by marshes, forming a flat having an average width of perhaps 1,000 feet. This marshy flat is subdivided transversely by low dikes having gates utilized in flooding the inclosed cranberry marshes. The soil is gravel, with sand at the surface and forming the hills. Much of the area is covered with scrub oak.

The drainage basin extends 4 miles westward from the visible heads of the two main branches, including an area of 25 square miles in which there are no visible streams. A well-marked dry stream valley reaches, however, from the junction of the branches to the westerly watershed line.

The drainage south of Peconic River basin comprises numerous small water courses in marshy valleys, the surface streams heading at but little distance above the limit of tide water.

The two eastern prongs of Long Island are comprised chiefly of absorbent sandy soils, affording very little surface run-off, and consequently having scarcely any surface streams.

Mean daily gage height, in feet, of Peconic River, at Calverton, Long Island, for 1903.

Day.	May.	June.	July.	Day.	May.	June.	July.	Day.	May.	June.	July.
1		1.10	1.20	12	1.22	1.42	1.15	22	1.20	1.30	
2		1.10	1.15	13	1.25	1.50	1.15	23	1.20	1.30	
3		1.10	1.15	14	1.30	1.40	1.15	24	1.20	1.28	
4		1.20	1.15	15	1.27	1.35	1.15	25	1.20	1.225	
5		1.20	1.15	16	1.25	1.30	1.12	26	1.20	1.20	
6		1.15	1.15	17	1.20	1.30		27	1.20	1.15	
7		1.15	1.15	18	1.20	1.30		28	1.20	1.15	
8		1.37	1.10	19	1.20	1.225		29	1.15	1.15	
9		1.40	1.10	20	1.20	1.20		30	1.15	1.22	
10		1.40	1.10	21	1.20	1.30		31	1.15		
11		1.32	1.10								

HYDROLOGIC CONDITIONS ON LONG ISLAND DURING 1903.

At the time the stream gaging was undertaken by the United States Geological Survey in April, 1903, the ground-water level was very high, as a result of heavy precipitation during the first sixteen days of April.

Beginning on April 17 a period of fifty-one days ensued with no precipitation of consequence. During this period the ground-water level in wells on Long Island fell steadily. The average lowering of ground water in a number of wells was as follows:

Minimum depth to ground water.	Depletion of ground water during drought of April to June, 1903.
	Feet.
0 to 5 feet	2.17
5 to 10 feet	1.62
10 to 15 feet	1.42
15 to 20 feet	1.35
20 to 25 feet	.92
Over 25 feet	.2 to .3

Data concerning the ground-water stages during this drought, in conjunction with the contemporary gagings, afford an opportunity to study the regimen of the streams in relation to ground water. The rainfall was so slight that little or no accretion to the ground-water supply occurred from this source. The condition of the soil above the ground-water table appears to have been that of continually decreasing saturation.

June 7 to 15, 1903, abnormally heavy rainfall occurred and was followed by considerable amounts of precipitation at frequent but irregular intervals to the end of the season, a condition tending to produce strata of differing saturation in the soil above the ground-water table, a disturbing factor in any attempted solution of the relations of rainfall, ground water, and run-off.

In order to facilitate comparison of the earlier gagings with the later data, the mean annual precipitation on Long Island and its departure from the normal has been presented in the following table, as given in the records compiled by the New York Water Supply Commission in 1903:

Precipitation on Long Island, 1903, at United States Weather Bureau stations.

Date.	Cutchogue.	Setauket.	Southampton.
	Inches.	*Inches.*	*Inches.*
March precipitation	1.26	1.05	1.20
April 1–16, inclusive	4.26	3.61	4.19
April 24	Tr.	Tr.	.....
May 3	.....	Tr.	.....
May 4	Tr.	.08	.14
May 5	Tr.	.07	.01
May 6	Tr.	.....	.09
May 7	.....	.02	.06
May 8	.05	.....	.....
May 20	.....	.....	.....
May 21	.25	.....	Tr.
May 22	.15	.14	.15
May 23	.....	.....	.03
May 24	.01	Tr.	Tr.
May 28	.....	.19	.....
May 30	.48	.....	.78
May 31	.....	.....	Tr.
Total, April 17 to June 6, inclusive	.94	.50	1.26
June 7–25, inclusive	5.17	6.49	4.47
June 29	.91	1.35	.20
July	1.89	2.26	1.66
August	7.77	6.28	7.37
September	1.25	2.61	1.24
October	4.53	3.66	3.42

Mean annual precipitation on Long Island.[a]

Year.	Precipitation.	Departure from normal.	Aggregate departure.	Year.	Precipitation.	Departure from normal.	Aggregate departure.	Year.	Precipitation.	Departure from normal.	Aggregate departure.
	Inches.	*Inches.*	*Inches.*		*Inches.*	*Inches.*	*Inches.*		*Inches.*	*Inches.*	*Inches.*
1826	54.31	+11.75	+11.75	1852	36.91	− 5.65	−75.09	1878	46.91	+ 3.35	−69.19
1827	50.79	+ 8.23	+19.48	1853	47.88	+ 5.32	−69.77	1879	40.07	− 2.49	−71.68
1828	43.95	+ 1.39	+21.37	1854	47.23	+ 4.67	−65.10	1880	39.19	− 3.37	−75.04
1829	45.07	+ 2.51	+23.88	1855	43.03	+ .47	−64.63	1881	35.53	− 7.03	−82.08
1830	45.41	+ 2.85	+26.73	1856	38.26	− 4.30	−68.93	1882	39.40	− 3.16	−85.24
1831	39.16	− 3.40	+23.33	1857	41.39	− 1.17	−70.10	1883	36.95	− 5.61	−90.85
1832	40.37	− 2.19	+21.14	1858	39.37	− 3.19	−73.29	1884	46.81	+ 4.25	−86.60
1833	38.45	− 4.11	+17.03	1859	58.29	+15.73	−57.56	1885	39.09	− 3.47	−90.07
1834	39.24	− 3.32	+13.71	1860	30.43	+12.13	−69.69	1886	48.64	+ 6.08	−83.99
1835	30.37	−12.19	+ 1.52	1861	39.27	− 3.29	−72.98	1887	47.07	+ 4.51	−79.48
1836	37.23	− 5.33	− 3.81	1862	43.35	+ .79	−72.19	1888	50.48	+ 7.92	−71.56
1837	35.29	− 7.27	−11.08	1863	41.18	− 1.38	−73.57	1889	55.66	+13.10	−58.46
1838	34.19	− 8.37	−19.45	1864	38.10	− 4.46	−78.03	1890	52.19	+ 9.63	−48.83
1839	38.90	− 3.66	−23.11	1865	43.49	+ .93	−77.10	1891	45.61	+ 3.05	−45.78
1840	37.34	− 5.22	−28.33	1866	45.79	+ 3.23	−73.87	1892	40.32	− 2.24	−48.02
1841	44.94	+ 2.38	−25.95	1867	45.80	+ 3.24	−70.63	1893	46.81	+ 4.25	−43.77
1842	39.47	− 3.09	−29.04	1868	45.01	+ 2.45	−68.18	1894	44.30	+ 1.74	−42.03
1843	36.69	− 5.87	−34.91	1869	45.67	+ 3.11	−65.07	1895	38.33	− 4.23	−46.26
1844	39.02	− 3.54	−38.45	1870	35.02	− 7.54	−72.61	1896	39.79	− 2.77	−49.03
1845	33.68	− 8.88	−47.33	1871	43.72	+ 1.16	−71.45	1897	50.95	+ 7.39	−41.64
1846	38.50	− 4.06	−51.39	1872	42.31	− .25	−71.70	1898	57.89	+15.33	−26.31
1847	46.77	+ 4.21	−47.18	1873	39.27	− 3.29	−74.99	1899	43.10	+ .54	−25.77
1848	33.14	− 9.42	−56.60	1874	41.47	− 1.09	−76.08	1900	45.19	+ 2.63	−23.14
1849	30.40	−12.16	−68.76	1875	44.43	+ 1.87	−74.21	1901	50.62	+ 8.06	−15.08
1850	45.39	− 2.83	−65.93	1876	45.67	+ 3.11	−71.10	1902	50.49	+ 7.93	− 7.15
1851	39.05	− 3.51	−69.44	1877	41.12	− 1.44	−72.54	1903	73.23	.....	.....

[a] From records of U. S. Signal Service, U. S. Weather Bureau, U. S. Army posts, New York State, etc., as compiled by New York Water Supply Commission.

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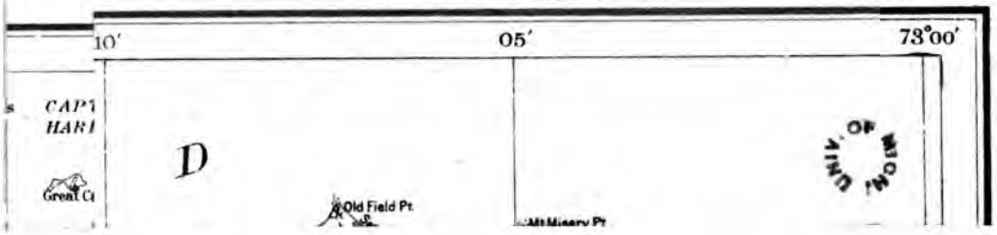

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